

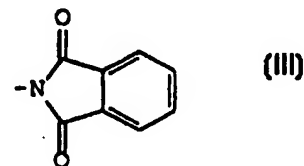
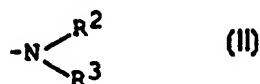
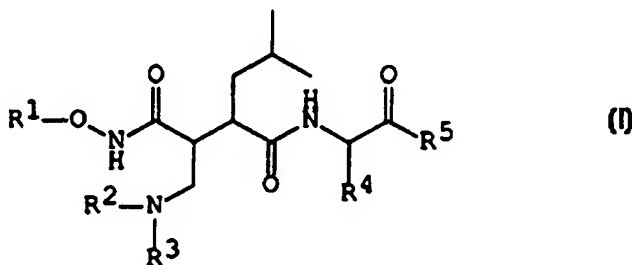


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<b>(21) International Application Number:</b> PCT/JP97/02004 <b>(22) International Filing Date:</b> 11 June 1997 (11.06.97)  <b>(30) Priority Data:</b> PO0482 14 June 1996 (14.06.96) AU  <b>(71) Applicant (for all designated States except US):</b> FUJISAWA PHARMACEUTICAL CO., LTD. [JP/JP]; 4-7, Doshomachi 3-chome, Chuo-ku, Osaka-shi, Osaka 541 (JP).  <b>(71) Applicant (for US only):</b> HEMMI, Mitsue (heirress of the deceased inventor) [JP/JP]; 668-37, Shimohirooka, Tsukuba-shi, Ibaraki 305 (JP).  <b>(72) Inventor:</b> HEMMI, Keiji (deceased).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> NEYA, Masahiro [JP/JP]; 4016-25, Hitana, Tsuchiura-shi, Ibaraki 300 (JP). URANO, Yasuharu [JP/JP]; 2-25-10, Matsushiro, Tsukuba-shi, Ibaraki 305 (JP). SHIMA, Ichiro [JP/JP]; 5-25-105, Gosyogaoka, Moriyamachi, Kitasouma-gun, Ibaraki 302-01 (JP).		<b>(74) Agent:</b> SEKI, Hideo; Fujisawa Pharmaceutical Co., Ltd., Osaka Factory, 1-6, Kashima 2-chome, Yodogawa-ku, Osaka-shi, Osaka 532 (JP).  <b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** SUCCINAMIDE DERIVATIVES USEFUL AS TNF- AND/OR MMP INHIBITORS**(57) Abstract**

A compound of formula (I), in which R<sup>1</sup> is hydrogen or hydroxy-protective group, R<sup>2</sup> is hydrogen or acyl, R<sup>3</sup> is hydrogen or lower alkyl, or the formula (II) is (III), R<sup>4</sup> is heterocyclic (lower) alkyl, and R<sup>5</sup> is lower alkoxy or lower alkylamino, or a pharmaceutically acceptable salt thereof, which is useful as a medicament.



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## DESCRIPTION

## SUCCINAMIDE DERIVATIVES USEFUL AS TNF- AND/OR MMP INHIBITORS

## 5 TECHNICAL FIELD

The present invention relates to new compound and pharmaceutically acceptable salts thereof.

10 More particularly, it relates to new compound and pharmaceutically acceptable salts thereof which are useful as inhibitors of matrix metalloproteinases (hereinafter to be referred to as MMP) or the production of tumor necrosis factor  $\alpha$  (hereinafter to be referred to as TNF  $\alpha$ ), to a pharmaceutical composition comprising the same, to use of the same as a medicament, and to a method for using the same therapeutically in the treatment and/or the prevention of MMP or TNF  $\alpha$  mediated diseases.

15 One object of the present invention is to provide new and useful compounds and pharmaceutically acceptable salts thereof which have pharmacological activities such as MMP or TNF  $\alpha$  inhibitory activity and the like.

20 Another object of the present invention is to provide a pharmaceutical composition comprising, as an active ingredient, said compound or a pharmaceutically acceptable salt thereof.

25 A further object of the present invention is to provide use of said compounds and pharmaceutically acceptable salts thereof as a medicament for prophylactic and therapeutic treatment of MMP or TNF  $\alpha$  mediated diseases.

30 A still further object of the present invention is to provide a method for using the same for the treatment and/or the prevention of MMP or TNF  $\alpha$  mediated diseases in mammals, especially humans.

35 The compounds of the present invention have inhibitory activity on MMP or the production of TNF  $\alpha$ , and

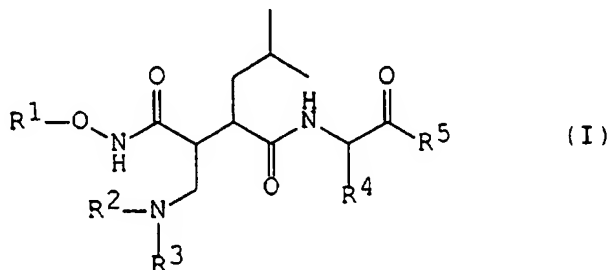
are useful in the treatment and/or prevention of a disease such as stroke, arthritis, cancer, tissue ulceration, decubitus ulcer, restenosis, periodontal disease, epidermolysis bullosa, scleritis, psoriasis and other diseases characterized by matrix metalloproteinase activity, as well as AIDS, sepsis, septic shock and other diseases caused by the production of TNF  $\alpha$ .

There are a number of enzymes which effect the breakdown of structural proteins and which are structurally related metalloproteases. Matrix-degrading metalloprotease, such as gelatinase (MMP-2, MMP-9), stromelysin (MMP-3) and collagenase (MMP-1), are involved in tissue matrix degradation and have been implicated in many pathological conditions involving abnormal connective tissue and basement membrane matrix metabolism, such as arthritis (e.g., osteoarthritis and rheumatoid arthritis), tissue ulceration (e.g., corneal, epidermal and gastric ulceration), abnormal wound healing, periodonal disease, bone disease (e.g., Paget's disease and osteoporosis), tumor matastasis or invasion as well as HIV-infection.

Tumor necrosis factor is recognized to be involved in many infections and autoimmune diseases. Furthermore, it has been shown that TNF is the prime mediator of the inflammatory response seen in sepsis and septic shock.

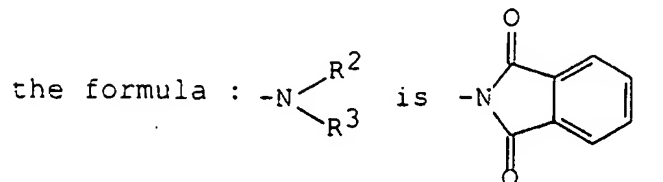
#### DISCLOSURE OF INVENTION

The object compound of the present invention can be represented by the following general formula :



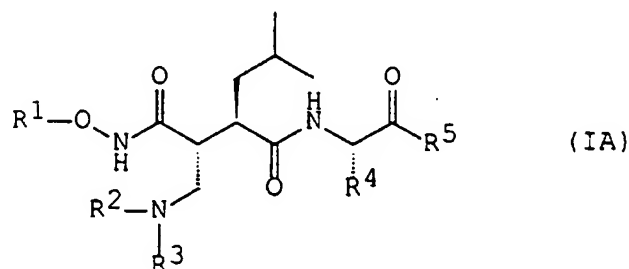


in which  $R^1$  is hydrogen or hydroxy-protective group,  
 $R^2$  is hydrogen or acyl,  
 $R^3$  is hydrogen or lower alkyl, or



$R^4$  is heterocyclic(lower)alkyl, and  
 $R^5$  is lower alkoxy or lower alkylamino,  
 or pharmaceutically acceptable salts thereof.

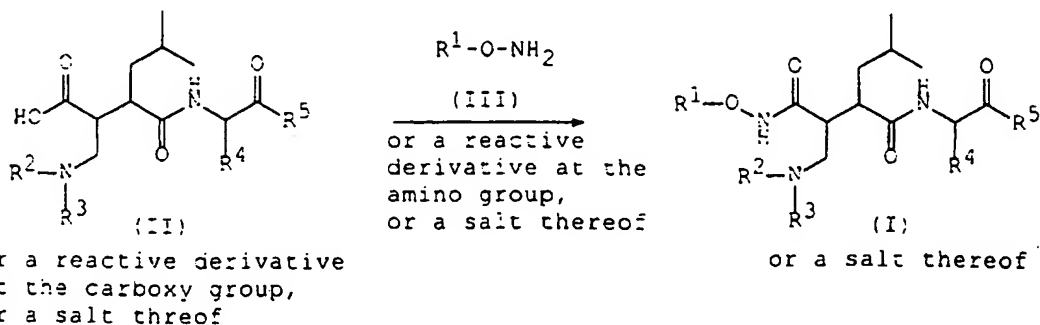
Further, the compound (I) having the most potent activities can be represented by the following configuration.



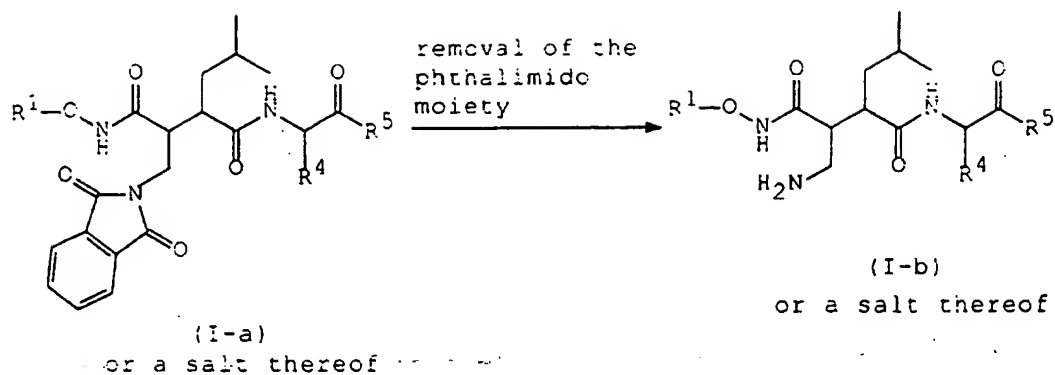
in which  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each as defined above.

According to the present invention, the new compound (I) and salts thereof can be prepared by the processes as shown in the following schemes.

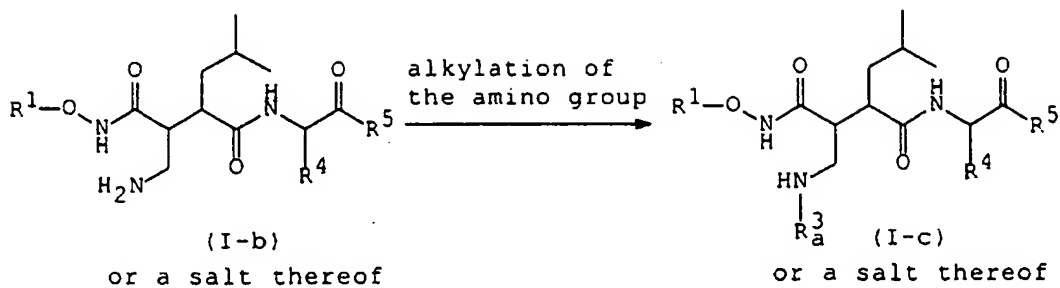
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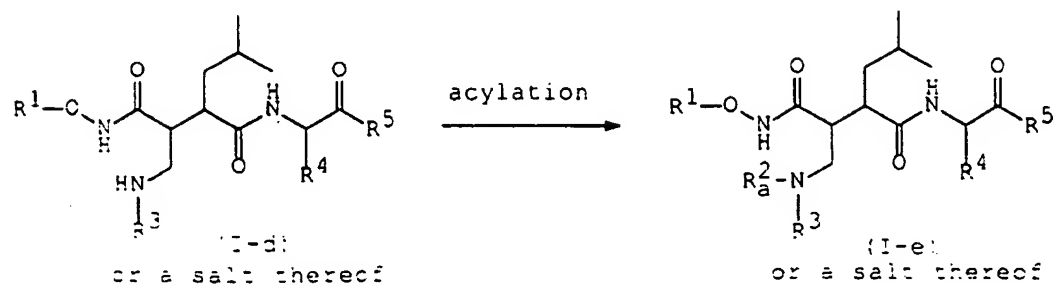
Process 2 :

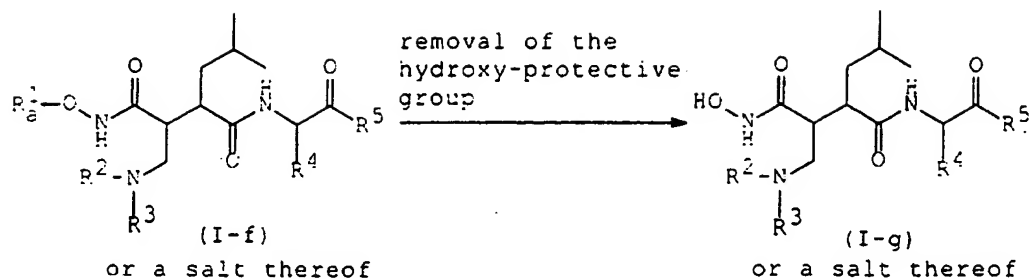
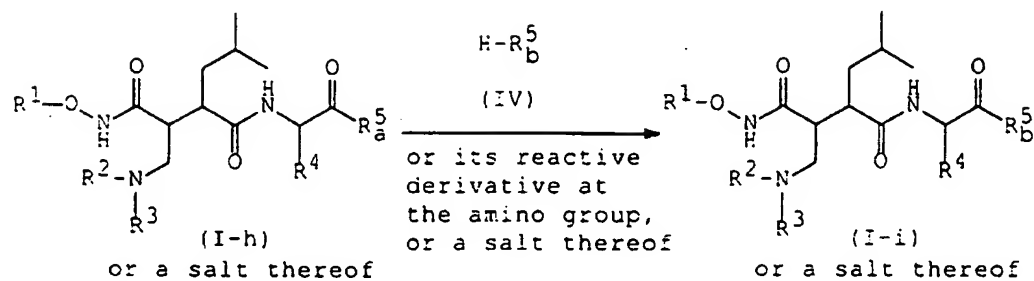
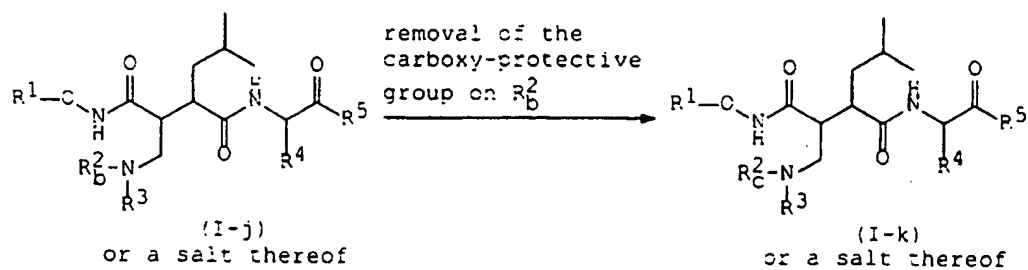


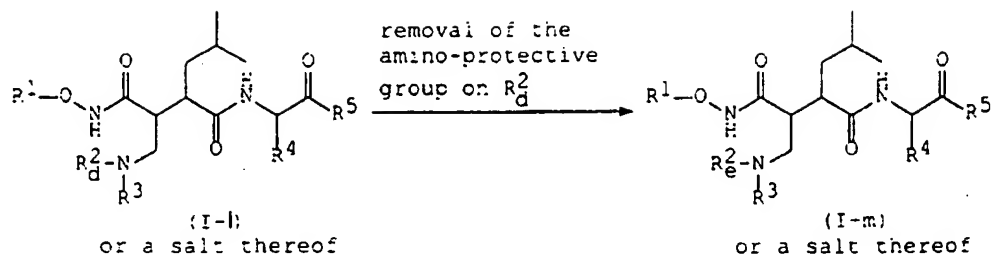
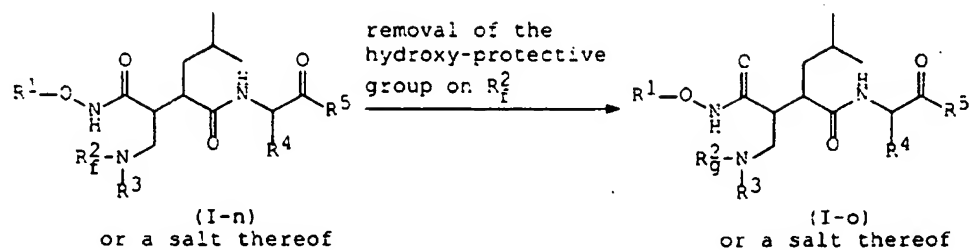
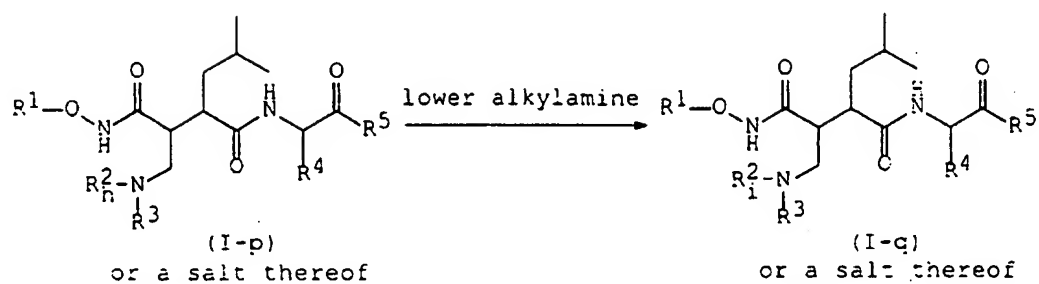
Process 3



Process 4



Process 5Process 6Process 7

Process 8Process 9Process 10

in which  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each as defined above,

$R_a^1$  is hydroxy-protective group,

$R_a^2$  is acyl,

$R_D^2$  is protected carboxy(lower)alkanoyl,

$R_C^2$  is carboxy(lower)alkanoyl,

$R_D^2$  is protected amino(lower)alkoxycarbonyl,

protected amino(lower)alkanoyl,

lower alkanoyl substituted by protected

amino and hydroxy, or N-protected

imidazolidinyl optionally substituted by

oxo,

$R_E^2$  is amino(lower)alkoxycarbonyl,

amino(lower)alkanoyl,

lower alkanoyl substituted by amino and

hydroxy, or imidazolidinyl optionally

substituted by oxo,

$R_F^2$  is protected hydroxy(lower)alkoxycarbonyl, or

protected hydroxy(lower)alkanoyl,

$R_G^2$  is hydroxy(lower)alkoxycarbonyl, or

hydroxy(lower)alkanoyl,

$R_H^2$  is lower alkoxycarbonyl(lower)alkylcarbamoyle

or lower alkoxycarbonyl(lower)alkanoyl,

$R_I^2$  is lower alkylcarbamoyle(lower)alkylcarbamoyle

or lower alkylcarbamoyle(lower)alkanoyl,

$R_a^3$  is lower alkyl,

$R_a^5$  is lower alkoxy, and

$R_D^5$  is lower alkylamino.

The starting compound (II) used in the Process 1 may be new and can be prepared by the following Preparations or by a conventional manner.

Suitable pharmaceutically acceptable salts of the object compound (I) may be a conventional non-toxic salt and include an acid addition salt such as an organic acid

salt (e.g. acetate, trifluoroacetate, maleate, tartrate, fumarate, methanesulfonate, benzenesulfonate, formate, toluenesulfonate, etc.), an inorganic acid salt (e.g. hydrochloride, hydrobromide, hydriodide, sulfate, nitrate, phosphate, etc.), or a salt with a base such as an amino acid (e.g. arginine, aspartic acid, glutamic acid, etc.), an alkali metal salt (e.g. sodium salt, potassium salt, etc.), an alkaline earth metal salt (e.g. calcium salt, magnesium salt, etc.), an ammonium salt, an organic base salt (e.g. trimethylamine salt, triethylamine salt, pyridine salt, picoline salt, dicyclohexylamine salt, N,N'-dibenzylethylenediamine salt, etc.), or the like.

The object compound (I) and pharmaceutically acceptable salts thereof may include a solvate (e.g., enclosure compound (e.g., hydrate, etc.)).

In the above and subsequent descriptions of the present specification, suitable examples and illustrations of the various definitions which the present invention includes within the scope thereof are explained in detail as follows.

The term "lower" is intended to mean 1 to 6 (or 2 to 6 for lower alkenyl group), preferably 1 to 4 carbon atoms (or 2 to 4 carbon atoms for the same), and the term "higher" is intended to mean more than 6, preferably 7 to 12 carbon atoms, unless otherwise indicated.

Suitable "hydroxy-protective group" may include a common one, for example, acyl as mentioned below, ar(lower)alkyl such as mono- or di- or triphenyl(lower)alkyl (e.g. benzyl, benzhydryl, trityl, phenethyl, naphthylmethyl, etc.), etc.; trisubstituted silyl such as tri(lower)alkylsilyl (e.g. trimethylsilyl, triethylsilyl, isopropyl dimethylsilyl, t-butyl dimethylsilyl, diisopropyl methylsilyl, etc.), triarylsilyl (e.g. triphenylsilyl, etc.), triar(lower)alkylsilyl (e.g. tribenzylsilyl, etc.), etc.;

and the like.

Preferable "hydroxy-protective group" thus defined may be C<sub>6</sub>-C<sub>10</sub> aroyl, C<sub>6</sub>-C<sub>10</sub> ar(lower)alkyl and lower alkanoyl, and the most preferable one may be benzyl.

5        Suitable "acyl" may include an aliphatic acyl, an aromatic acyl, a heterocyclic acyl and an aliphatic acyl substituted with aromatic or heterocyclic group(s) derived from acids such as carboxylic, carbonic, carbamic, sulfonic acids, wherein said heterocyclic group(s) may be  
10        the same as those mentioned below.

      The aliphatic acyl may include saturated or unsaturated, acyclic or cyclic ones, such as carbamoyl, oxamoyl, lower alkanoyl optionally substituted by halogen (e.g. chloro, fluoro, iodo, bromo, etc.) (e.g. formyl,  
15        acetyl, propionyl, butyryl, isobutyryl, valeryl, isovaleryl, pivaloyl, hexanoyl, trifluoroacetyl, etc.), lower alkanesulfonyl (e.g. mesyl, ethanesulfonyl, propanesulfonyl, etc.), lower alkoxycarbonyl (e.g. methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl,  
20        isopropoxycarbonyl, butoxycarbonyl, isobutoxycarbonyl, t-butoxycarbonyl, etc.), lower alkenoyl (e.g. acryloyl, methacryloyl, crotonoyl, etc.), (C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl (e.g. cyclopropanecarbonyl, cyclobutanecarbonyl, cyclohexanecarbonyl, etc.), (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl(lower)-  
25        alkanoyl (e.g. cyclohexylacetyl, etc.), amidino, protected carboxycarbonyl such as lower alkoxalyl (e.g. methoxalyl, ethoxalyl, t-butoxalyl, etc.), mono- or di(lower)alkyl-amino(lower)alkanoyl (e.g. dimethylaminoacetyl, etc.);  
30        lower or higher alkylcarbamoyl (e.g. methylcarbamoyl, ethylcarbamoyl, propylcarbamoyl, isopropylcarbamoyl, butylcarbamoyl, t-butylcarbamoyl,  
      2-methylbutylcarbamoyl, pentylcarbamoyl, hexylcarbamoyl, heptylcarbamoyl, octylcarbamoyl, nonylcarbamoyl, etc.), di(lower)alkylcarbamoyl (e.g. dimethylcarbamoyl,  
35        diethylcarbamoyl, dipropylcarbamoyl, diisopropylcarbamoyl,

dibutylcarbamoyl, diisobutylcarbamoyl, dihexylcarbamoyl, etc.), C<sub>3</sub>-C<sub>7</sub> cycloalkylcarbamoyl (e.g. cyclopropylcarbamoyl, cyclobutylcarbamoyl, cyclopentylcarbamoyl, cyclohexylcarbamoyl, cycloheptylcarbamoyl, etc.), N-lower alkyl-N-(C<sub>3</sub>-C<sub>7</sub>)-cycloalkylcarbamoyl (e.g. N-methyl-N-cyclopropylcarbamoyl, N-methyl-N-cyclohexylcarbamoyl, N-ethyl-N-cyclohexylcarbamoyl, N-propyl-N-cyclohexylcarbamoyl, etc.), di(C<sub>3</sub>-C<sub>7</sub>)cyclohexylcarbamoyl (e.g. dicyclopropylcarbamoyl, dicyclopentylcarbamoyl, dicyclohexylcarbamoyl, etc.), N-[di(lower)alkylcarbamoyl(C<sub>3</sub>-C<sub>7</sub>)cycloalkyl]carbamoyl [e.g. N-(1-dimethylcarbamoylcyclohexyl)carbamoyl, etc.], N-[di(lower)alkylcarbamoyl(lower)alkyl(C<sub>3</sub>-C<sub>7</sub>)cycloalkyl]-carbamoyl [e.g. N-[1-(dimethylcarbamoylmethyl)cyclohexyl]-carbamoyl, etc.], N-[carbamoyl(lower)alkyl]carbamoyl [e.g. N-[1-carbamoyl]-2-methylbutyl]carbamoyl, etc.], N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl [e.g. N-(methylcarbamoylmethyl)carbamoyl, N-(1-isopropylcarbamoyl-2-methylbutyl)carbamoyl, etc.], N-[N,N-lower alkylenecarbamoyl(lower)alkyl]carbamoyl [e.g. N-[2-methyl-1-(piperidinocarbonyl)butyl]carbamoyl, etc.], N-[N,N-di(lower)alkylcarbamoyl(lower)alkyl]carbamoyl [e.g. N-(dimethylcarbamoylmethyl)carbamoyl, N-[1-(dimethylcarbamoyl)ethyl]carbamoyl, N-[1-(dimethylcarbamoyl)-2-methylpropyl]carbamoyl, N-[2,2-dimethyl-1-(dimethylcarbamoyl)propyl]carbamoyl, N-[2-methyl-1-(dimethylcarbamoyl)butyl]carbamoyl, N-[2-methyl-1-(diethylcarbamoyl)butyl]carbamoyl, N-[3-methyl-1-(dimethylcarbamoyl)butyl]carbamoyl, N-(1-dimethylcarbamoylpentyl)carbamoyl, etc.], N-(lower)alkyl-N-[N,N-di(lower)alkylcarbamoyl](lower)-alkylcarbamoyl [e.g. N-methyl-N-[1-dimethylcarbamoyl-2-methylbutyl]carbamoyl, N-methyl-N-[1-dimethylcarbamoyl-3-methylbutyl]carbamoyl, etc.], and the like.



The aromatic acyl may include C<sub>6</sub>-C<sub>10</sub> aroyl (e.g. benzoyl, toluoyl, xyloyl, etc.), C<sub>6</sub>-C<sub>10</sub> arenesulfonyl (e.g. benzenesulfonyl, tosyl, etc.), C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl (e.g. phenylcarbamoyl, etc.), C<sub>6</sub>-C<sub>10</sub> aryloxalyl (e.g. phenyloxalyl, etc.), and the like.

The heterocyclic acyl may include heterocyclic-carbonyl such as furoyl, thenoyl, nicotinoyl, isonicotinoyl, oxolanecarbonyl optionally substituted by oxo (e.g. 2-oxo-5-oxolanecarbonyl, etc.), thiazolylcarbonyl, thiadiazolylcarbonyl, indolylcarbonyl, isoindolylcarbonyl, tetrazolylcarbonyl, morpholinocarbonyl, pyrrolylcarbonyl, pyrazinylcarbonyl, thiomorpholinocarbonyl, pyridinecarbonyl optionally substituted by lower alkyl [e.g. 2-(or 3- or 4-)-pyridinecarbonyl, 6-methyl-2-pyridinecarbonyl, 2-methyl-5-pyridinecarbonyl, etc.], quinolinecarbonyl optionally substituted by hydroxy (e.g. 2-quinolinecarbonyl, 3-quinolinecarbonyl, 4-hydroxy-2-quinolinecarbonyl, etc.), lower alkyleneaminocarbonyl optionally substituted by oxo (e.g. aziridin-1-ylcarbonyl, azetidin-1-ylcarbonyl, pyrrolidin-1-ylcarbonyl, piperidin-1-ylcarbonyl, hexahydro-1H-azepin-1-ylcarbonyl, octahydroazocin-1-ylcarbonyl, tetrahydroquinolinecarbonyl, tetrahydroisoquinolinecarbonyl, dihydropyridinecarbonyl, tetrahydropyridinecarbonyl, 2-oxo-5-pyrrolidinecarbonyl, 2-oxo-4-imidazolidinecarbonyl, etc.), heterocyclic-carbamoyl such as pyridylcarbamoyl (e.g. 4-pyridylcarbamoyl, etc.), piperidylcarbamoyl, etc. and the like.

The aliphatic acyl substituted with aromatic group(s) may include (C<sub>6</sub>-C<sub>10</sub>)ar(lower)alkanoyl such as phenyl(lower)alkanoyl (e.g. phenylacetyl, phenylpropionyl, phenylhexanoyl, etc.), (C<sub>6</sub>-C<sub>10</sub>)ar(lower)alkoxycarbonyl such as phenyl(lower)alkoxycarbonyl (e.g. benzyloxycarbonyl, phenethyloxycarbonyl, etc.),

(C<sub>6</sub>-C<sub>10</sub>)aryloxy(lower)alkanoyl such as phenoxy(lower)alkanoyl (e.g. phenoxyformyl, phenoxyacetyl, phenoxypropionyl, etc.), ar(lower)alkoxalyl such as phenyl(lower)alkoxalyl (e.g. benzyloxalyl, etc.),  
5 ar(lower)alkenoyl such as phenyl(lower)alkenoyl (e.g. cinnamoyl, etc.), ar(lower)alkylsulfonyl (e.g. benzylsulfonyl, etc.), and the like.

The aliphatic acyl substituted with heterocyclic group(s) may include heterocyclic(lower)alkanoyl such as  
10 thienyl(lower)alkanoyl, imidazolyl(lower)alkanoyl (e.g. 4-imidazolylacetyl, etc.), furyl(lower)alkanoyl, tetrazolyl(lower)alkanoyl, thiazolyl(lower)alkanoyl, thiadiazolyl(lower)alkanoyl, pyridyl(lower)alkanoyl (e.g. pyridin-3-ylacetyl, 3-(pyridin-3-yl)propionyl, etc.),  
15 lower alkyleneamino(lower)alkanoyl (e.g. 3-(piperidin-1-yl)propionyl, etc.), etc.; heterocyclic(lower)alkylcarbamoyl, such as pyridyl(lower)alkylcarbamoyl, etc.; and the like.

These acyl groups may be further substituted with one  
20 or more, preferably one to three suitable substituents such as carboxy, lower alkyl (e.g. methyl, ethyl, propyl, isopropyl, butyl, t-butyl, pentyl, hexyl, etc.), halogen, (e.g. chlorine, bromine, iodine, fluorine), carbamoyl, mono- or di(lower)alkylcarbamoyl (e.g. methylcarbamoyl, etc.),  
25 amino, protected amino such as lower alkanoylamino (e.g. formamido, acetamido, propionamido, etc.), and lower alkoxycarbonylamino (e.g. t-butoxycarbonylamino, etc.), mono- or di(lower)alkylamino (e.g. dimethylamino, etc.), lower alkoxycarbonylamino (e.g. t-butoxycarbonylamino, etc.),  
30 lower alkylsulfonyl (e.g. methylsulfonyl, etc.), arylsulfonyl (e.g. phenylsulfonyl, tosyl, etc.), ar(lower)alkyl (e.g. benzyl, etc.), hydroxy, lower alkoxy (e.g. methoxy, ethoxy, propoxy, isopropoxy, butoxy, t-butoxy, etc.), carboxy, protected carboxy as mentioned  
35 below such as lower alkoxycarbonyl (e.g. methoxycarbonyl,

etc.), carboxy(lower)alkyl (e.g. carboxymethyl, carboxyethyl, etc.), protected carboxy(lower)alkyl (e.g. t-butoxycarbonylmethyl, etc.), lower alkanoyloxy (e.g. acetoxy, etc.), lower alkoxycarbonyl (e.g. methoxycarbonyl, etc.), amino- or imino-protective group such as acyl (e.g. benzyloxycarbonyl, etc.), and the like.

Preferable acyl thus defined may be :

- lower alkanoyl (e.g. acetyl, propionyl, etc.);
- 10 - di(lower)alkylcarbamoyl (e.g. dimethylcarbamoyl, etc.);
- C<sub>6</sub>-C<sub>10</sub> aroyl (e.g. benzoyl, etc.);
- C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl (e.g. phenylcarbamoyl, etc.);
- heterocyclecarbonyl such as  
pyridinecarbonyl optionally substituted by lower alkyl  
15 [e.g. 2-(or 3- or 4-)pyridinecarbonyl, 3-methyl-2-pyridinecarbonyl, 4-methyl-3-pyridinecarbonyl, etc.];  
quinolinecarbonyl optionally substituted by hydroxy  
(e.g. 2-quinolinecarbonyl, 3-quinolinecarbonyl, 4-hydroxy-2-quinolinecarbonyl, etc.); etc.;
- 20 - lower alkyleneaminocarbonyl (e.g. pyrrolidin-1-ylcarbonyl, etc.);
- heterocyclic(lower)alkanoyl such as  
pyridyl(lower)alkanoyl (e.g. pyridin-3-ylacetyl, 3-(pyridin-3-yl)propionyl, etc.); etc.;
- 25 - lower alkanoyl substituted by mono- or di(lower)alkylamino (e.g. dimethylaminoacetyl, etc.);  
and the like;

wherein said heterocyclic group may be saturated or unsaturated 3- to 8-membered (preferably 5- or 6-membered)  
30 heteromonocyclic group containing 1 to 4 nitrogen atom(s), or unsaturated 7- to 12-membered condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s).

35 Another preferable acyl thus defined may be :

- (1) oxamoyl;
- (2) lower alkanoyl (e.g. acetyl, propionyl, isobutyryl, pivaloyl, etc.) optionally substituted by halogen (e.g. trifluoroacetyl, etc.);
- 5 (3) lower alkanesulfonyl (e.g. mesyl, ethanesulfonyl, etc.);
- (4) lower alkoxy carbonyl (e.g. methoxy carbonyl, ethoxy carbonyl, isopropoxy carbonyl, isobutoxy carbonyl, t-butoxy carbonyl, etc.);
- 10 (5) (C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl (e.g. cyclopropanecarbonyl, etc.);
- (6) di(lower)alkylamino(lower)alkanoyl (e.g. dimethylaminoacetyl, etc.);
- (7) lower alkylcarbamoyl (e.g. methylcarbamoyl, ethylcarbamoyl, isopropylcarbamoyl, t-butylcarbamoyl, etc.);
- 15 (8) di(lower)alkylcarbamoyl (e.g. dimethylcarbamoyl, etc.);
- (9) N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl (e.g. N-(methylcarbamoylmethyl)carbamoyl, etc.);
- (10) C<sub>6</sub>-C<sub>10</sub> aroyl (e.g. benzoyl, etc.);
- 20 (11) C<sub>6</sub>-C<sub>10</sub> arenesulfonyl (e.g. benzenesulfonyl, etc.);
- (12) C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl (e.g. phenylcarbamoyl, etc.);
- (13) heterocyclic-carbonyl optionally substituted by the group consisting of acyl such as C<sub>6</sub>-C<sub>10</sub> ar(lower)alkoxy carbonyl (e.g. benzyloxy carbonyl, etc.), lower alkyl (e.g. methyl, etc.), hydroxy and oxo; said heterocyclic group being
- 25 unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s), for example, azepinyl (e.g. 1H-azepinyl, etc.), pyrrolyl, pyrrolinyl, imidazolyl, pyrazolyl, pyridyl and its N-oxide, dihydropyridyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl (e.g. 4H-1,2,4-triazolyl, 1H-1,2,3-triazolyl, 2H-1,2,3-triazolyl, etc.), tetrazolyl (e.g. 1H-tetrazolyl, 2H-tetrazolyl, etc.), etc.;
- 30
- 35

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s), for example, perhydroazepinyl (e.g. perhydro-1H-azepinyl, etc.), pyrrolidinyl, imidazolidinyl, piperidinyl (e.g. piperidino, etc.), piperazinyl, etc.;

unsaturated 7- to 12-membered (more preferably 9- or 10- membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s), for example, indolyl, isoindolyl, indolizinyll, benzimidazolyl, quinolyl, isoquinolyl, indazolyl, benzotriazolyl, etc.;

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom, for example, furyl, etc.;

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom, for example, oxolanyl, etc.; and the like, for example,

- pyrrolylcarbonyl (e.g. 2-pyrrolylcarbonyl, etc.);
- pyridinecarbonyl ([e.g. 2-(or 3- or 4-)pyridinecarbonyl, etc.) optionally substituted by lower alkyl (e.g. 6-methyl-2-pyridinecarbonyl, 2-methyl-5-pyridinecarbonyl, etc.);
- pyrazinylcarbonyl (e.g. pyrazin-2-ylcarbonyl, etc.);
- pyrrolidinylcarbonyl (e.g. pyrrolidin-1-ylcarbonyl, etc.) optionally substituted by oxo (e.g. 2-oxopyrrolidin-5-ylcarbonyl, etc.);
- imidazolizinyllcarbonyl optionally substituted by the group consisting of oxo and C<sub>6</sub>-C<sub>10</sub> ar(lower)-alkoxycarbonyl (e.g. 2-oxo-4-imidazolizinecarbonyl, 1-benzyloxycarbonyl-2-oxo-4-imidazolidinecarbonyl, etc.);
- quinolinecarbonyl (e.g. 2-quinolinecarbonyl, 3-quinolinecarbonyl, etc.) optionally substituted by hydroxy (e.g. 4-hydroxy-2-quinolinecarbonyl, etc.);

- indolylcarbonyl; isoindolylcarbonyl;
- furyl (e.g. 2-(or 3-)furylcarbonyl, etc.);
- oxolanecarbonyl optionally substituted by oxo (e.g. 2-oxo-5-oxolanecarbonyl, etc.); and the like;

5 (14) heterocyclic-carbamoyl; said heterocyclic group being  
unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s), for example, azepinyl (e.g. 1H-  
azepinyl, etc.), pyrrolyl, pyrrolinyl, imidazolyl,  
10 pyrazolyl, pyridyl and its N-oxide, dihydropyridyl,  
pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl (e.g. 4H-  
1,2,4-triazolyl, 1H-1,2,3-triazolyl, 2H-1,2,3-triazolyl,  
etc.), tetrazolyl (e.g. 1H-tetrazolyl, 2H-tetrazolyl,  
etc.), etc.;

15 saturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s), for example, perhydroazepinyl (e.g.  
perhydro-1H-azepinyl, etc.), pyrrolidinyl,  
imidazolidinyl, piperidinyl (e.g. piperidino, etc.),  
20 piperazinyl, etc.;

unsaturated 7- to 12-membered (more preferably 9-  
to 10-membered) condensed (preferably bicyclic)  
heterocyclic group containing 1 to 4 nitrogen atom(s),  
for example, indolyl, isoindolyl, indolizinyl,  
25 benzimidazolyl, quinolyl, isoquinolyl, indazolyl,  
benzotriazolyl, etc.;

unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom, for example, furyl, etc.;

30 saturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom, for example, oxolanyl, etc.; and the like,  
for example,  
- pyridylcarbamoyl (e.g. 4-pyridylcarbamoyl, etc.); and  
35 the like;

(15) (C<sub>6</sub>-C<sub>10</sub>)aryloxy(lower)alkanoyl such as  
phenoxy(lower)alkanoyl (e.g. phenoxyformyl, etc.); etc.;

(16) heterocyclic(lower)alkanoyl; said heterocyclic group  
being

5           unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s), for example, azepinyl (e.g. 1H-  
azepinyl, etc.), pyrrolyl, pyrrolinyl, imidazolyl,  
pyrazolyl, pyridyl and its N-oxide, dihydropyridyl,  
10       pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl (e.g. 4H-  
1,2,4-triazolyl, 1H-1,2,3-triazolyl, 2H-1,2,3-triazolyl,  
etc.), tetrazolyl (e.g. 1H-tetrazolyl, 2H-tetrazolyl,  
etc.), etc.;

          saturated 3- to 8-membered (more preferably 5- or  
15       6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s), for example, perhydroazepinyl (e.g.  
perhydro-1H-azepinyl, etc.), pyrrolidinyl,  
imidazolidinyl, piperidinyl (e.g. piperidino, etc.),  
piperazinyl, etc.;

20           unsaturated 7- to 12-membered (more preferably 9-  
to 10-membered) condensed (preferably bicyclic)  
heterocyclic group containing 1 to 4 nitrogen atom(s),  
for example, indolyl, isoindolyl, indolizinyl,  
benzimidazolyl, quinolyl, isoquinolyl, indazolyl,  
25       benzotriazolyl, etc.;

          unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom, for example, furyl, etc.;

30           saturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom, for example, oxolanyl, etc.; and the like,  
for example,

- imidazolyl(lower)alkanoyl (e.g. 4-imidazolylacetyl,  
etc.);

35       - pyridyl(lower)alkanoyl (e.g. pyridin-3-ylacetyl, 3-

- (pyridin-3-yl)propionyl, etc.);
- piperidinylloweralkanoyl [e.g. 3-(piperidin-1-yl)propionyl, etc.];
- (17) lower alkylcarbamoyleloweralkanoyl (e.g. methylcarbamoyleacetyl, etc.);
- (18) carboxyloweralkanoyl (e.g. carboxyacetyl, 3-carboxypropionyl, etc.);
- (19) protected carboxyloweralkanoyl such as lower alkoxycarbonylloweralkanoyl (e.g. ethoxycarbonylacetyl, etc.); etc.;
- (20) hydroxyloweralkanoyl (e.g. hydroxyacetyl, 2,3-dihydroxypropionyl, 2,3,4,5,6-pentahydroxyhexanoyl, etc.);
- (21) protected hydroxyloweralkanoyl such as lower alkanoyloxyloweralkanoyl (e.g. acetoxyacetyl, etc.); etc.;
- (22) lower alkoxy(lower)alkanoyl (e.g. methoxyacetyl, etc.);
- (23) lower alkoxy(lower)alkoxycarbonyl (e.g. 2-methoxyethoxycarbonyl, etc.);
- (24) amino(lower)alkoxycarbonyl (e.g. 2-aminoethoxycarbonyl, etc.);
- (25) protected amino(lower)alkoxycarbonyl such as C<sub>6</sub>-C<sub>10</sub> ar(lower)alkoxycarbonylamino(lower)alkoxycarbonyl (e.g. 2-(benzyloxycarbonylamino)ethoxycarbonyl, etc.);
- (26) lower alkoxycarbonylloweralkylcarbamoyle (e.g. methoxycarbonylmethylcarbamoyle, etc.);
- (27) lower alkylsulfonylloweralkanoyl (e.g. methylsulfonylacetyl, etc.);
- (28) hydroxyloweralkoxycarbonyl (e.g. 2-hydroxyethoxycarbonyl, etc.);
- (29) protected hydroxyloweralkoxycarbonyl such as lower alkanoyloxy(lower)alkoxycarbonyl (e.g. 2-acetoxyethoxycarbonyl, etc.); etc.;
- (30) lower alkanoyl substituted by the group consisting of amino and hydroxy (e.g. 2-amino-3-hydroxypropionyl,



etc.);

(31) lower alkanoyl substituted by the group consisting of protected amino and hydroxy such as lower alkanoyl substituted by the group consisting of lower alkoxy

5 alkoxy carbonylamino and hydroxy (e.g. 2-t-butoxy carbonylamino-3-hydroxypropionyl, etc.); etc.;

(32) amino(lower)alkanoyl (e.g. aminoacetyl, etc.);

(33) protected amino(lower)alkanoyl such as lower alkanoylamino(lower)alkanoyl (e.g. acetamidoacetyl, etc.), lower alkoxy carbonylamino(lower)alkanoyl (e.g. t-butoxy carbonylaminoacetyl, etc.); etc.;

10

and the like.

Suitable "lower alkyl" or lower alkyl moiety may include, unless otherwise indicated, a straight or

15 branched one such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, pentyl, hexyl, and the like, in which the most preferred example may be methyl for  $R^3$ .

Suitable "lower alkoxy" or lower alkoxy moiety may include, unless otherwise indicated, a straight or

20 branched one such as methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, tert-butoxy, pentyloxy, hexyloxy, and the like, in which the most preferable example may be methoxy for  $R^5$ .

Preferable "heterocyclic(lower)alkyl" means lower alkyl substituted by heterocyclic group as mentioned below, in which more preferable heterocyclic group may be saturated or unsaturated 3- to 8-membered (preferably 5- or 6-

25 membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s), or unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s), wherein

30 preferable example of heterocyclic(lower)alkyl may be

35

pyridyl(lower)alkyl, and the most preferable one may be 2-pyridylmethyl and 4-pyridylmethyl.

5        Suitable "heterocyclic group" as mentioned above may include saturated or unsaturated, monocyclic or polycyclic heterocyclic group containing at least one hetero-atom such as oxygen, sulfur and nitrogen atom.

10        Preferable heterocyclic group may be  
         unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s), for example, azepinyl (e.g. 1H-azepinyl, etc.) pyrrolyl, pyrrolinyl, imidazolyl, pyrazolyl, pyridyl  
15        and its N-oxide, dihydropyridyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl (e.g. 4H-1,2,4-triazolyl, 1H-1,2,3-triazolyl, 2H-1,2,3-triazolyl, etc.), tetrazolyl (e.g. 1H-tetrazolyl, 2H-tetrazolyl, etc.), etc.;

         saturated 3- to 8-membered (more preferably 5- or 6-  
20        membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s), for example, perhydroazepinyl (e.g. perhydro-1H-azepinyl, etc.), pyrrolidinyl, imidazolidinyl, piperidinyl (e.g. piperidino, etc.), piperazinyl, etc.;

         unsaturated 7- to 12-membered (more preferably 9- to  
25        10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s), for example, indolyl, isoindolyl, indolizinyl, benzimidazolyl, quinolyl, isoquinolyl, indazolyl, benzotriazolyl, etc.;

         saturated 7- to 12-membered (more preferably 9- to 10-  
30        membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s), for example, 7-azabicyclo[2.2.1]heptyl, 3-azabicyclo[3.2.2]nonanyl, etc.;

         unsaturated 3- to 8-membered (more preferably 5- or 6-  
35        membered) heteromonocyclic group containing 1 to 2 oxygen

atom(s) and 1 to 3 nitrogen atom(s), for example, oxazolyl, isoxazolyl, oxadiazolyl (e.g. 1,2,4-oxadiazolyl, 1,3,4-oxadiazolyl, 1,2,5-oxadiazolyl, etc.), etc.;

5 saturated 3- to 8-membered (more preferably 5- to 7-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s) and 1 to 3 nitrogen atom(s), for example, morpholinyl (e.g. morpholino, etc.), sydnonyl, etc.;

10 unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 2 oxygen atom(s) and 1 to 3 nitrogen atom(s), for example, benzoxazolyl, benzoxadiazolyl, etc.;

15 unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3 nitrogen atom(s), for example, thiazolyl, isothiazolyl, thiadiazolyl (e.g. 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,3,4-thiadiazolyl, 1,2,5-thiadiazolyl, etc.), dihydrothiazinyl, etc.;

20 saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3 nitrogen atom(s), for example, thiazolidinyl, etc.;

25 unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3 nitrogen atom(s), for example, benzothiazolyl, benzothiadiazolyl, etc.;

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s), for example, furyl, etc.;

30 saturated 3- to 8-membered (morepreferably 5- or 6-membered) heterocyclic group containing 1 to 2 oxygen atom(s), for example, oxolanyl, etc.;

35 unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing an oxygen atom and 1 to 2 sulfur atom(s), for example, dihydrooxathiinyl,

etc.;

unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 2 sulfur atom(s), for example,

5    benzothienyl, benzodithiynyl, etc.;

unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing an oxygen atom and 1 to 2 sulfur atom(s), for example, benzoxathiynyl, etc., and the like.

10    Suitable "lower alkylamino" may include conventional one such as methylamino, ethylamino, propylamino, isopropylamino, butylamino, pentylamino, hexylamino, and the like, in which more preferable example may be C<sub>1</sub>-C<sub>4</sub> alkylamino and the most preferable one may be methylamino.

15

Preferable Examples of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are as follows :

R<sup>1</sup> is hydrogen,

R<sup>2</sup> is hydrogen or acyl,

20    R<sup>3</sup> is hydrogen or lower alkyl,

R<sup>4</sup> is heterocyclic(lower)alkyl,

wherein said heterocyclic group being saturated or unsaturated 5- or 6-membered heteromonocyclic group containing 1 to 4 nitrogen atom(s) [e.g. 2-(or 4-)-

25    pyridylmethyl, etc.], and

R<sup>5</sup> is lower alkoxy or lower alkylamino.

Another preferable examples of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are as follows:

30    R<sup>1</sup> is hydrogen,

R<sup>2</sup> is hydrogen; acyl such as oxamoyl; lower alkanoyl;

lower alkanesulfonyl; lower alkoxycarbonyl;

(C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl;

di(lower)alkylamino(lower)alkanoyl;

35    lower alkylcarbamoyl; di(lower)alkylcarbamoyl;

N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl; C<sub>6</sub>-C<sub>10</sub> aroyl; C<sub>6</sub>-C<sub>10</sub> arenesulfonyl; C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl; heterocyclic-carbonyl optionally substituted by the group consisting of acyl such as C<sub>6</sub>-C<sub>10</sub>

ar(lower)alkoxycarbonyl, lower alkyl, hydroxy and oxo, said heterocyclic group being

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s),

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s), or

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s);

heterocyclic-carbamoyl, said heterocyclic group being

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s),

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s), or

saturated 3- to 8-membered (more preferably 5- or

6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s);

(C<sub>6</sub>-C<sub>10</sub>)aryloxy(lower)alkanoyl;

heterocyclic(lower)alkanoyl, said heterocyclic group being

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s)

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 7- to 12-membered (more preferably 9- to 10-membered) condensed (preferably bicyclic) heterocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s), or

saturated 3- to 8-membered (more preferably 5- or 6-membered) heteromonocyclic group containing 1 to 2 oxygen atom(s);

lower alkylcarbamoyl(lower)alkanoyl;

carboxy(lower)alkanoyl; protected

carboxy(lower)alkanoyl; hydroxy(lower)alkanoyl;

protected hydroxy(lower)alkanoyl;

lower alkoxy(lower)alkanoyl;

lower alkoxy(lower)alkoxycarbonyl;

amino(lower)alkoxycarbonyl;

protected amino(lower)alkoxycarbonyl;

lower alkoxycarbonyl(lower)alkylcarbamoyl;

lower alkylsulfonyl(lower)alkanoyl;

hydroxy(lower)alkoxycarbonyl;

protected hydroxy(lower)alkoxycarbonyl; lower alkanoyl

substituted by the group consisting of amino and

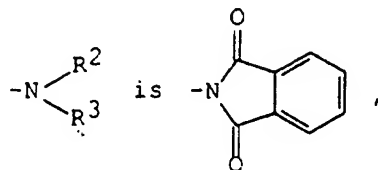
hydroxy; lower alkanoyl substituted by the group

consisting of protected amino and hydroxy;

amino(lower)alkanoyl; or protected

amino(lower)alkanoyl;

R<sup>3</sup> is hydrogen or lower alkyl, or the formula:



R<sup>4</sup> is heterocyclic(lower)alkyl,

10 said heterocyclic group being  
unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s),

15 saturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 4  
nitrogen atom(s),

unsaturated 7- to 12-membered (more preferably 9-  
to 10-membered) condensed (preferably bicyclic)  
heterocyclic group containing 1 to 4 nitrogen atom(s),

20 unsaturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom(s), or

25 saturated 3- to 8-membered (more preferably 5- or  
6-membered) heteromonocyclic group containing 1 to 2  
oxygen atom(s),

R<sup>5</sup> is lower alkoxy or lower alkylamino.

The processes for preparing the object compound (I)  
are explained in detail in the following.

30

#### Process 1

The object compound (I) or a salt thereof can be  
prepared by reacting the compound (II) or its reactive  
derivative at the carboxy group, or a salt thereof with  
35 the compound (III) or its reactive derivative at the amino

group, or a salt thereof.

Suitable reactive derivative at the amino group of the compound (III) may include Schiff's base type imino or its tautomeric enamine type isomer formed by the reaction of the compound (III) with a carbonyl compound such as aldehyde, ketone or the like; a silyl derivative formed by the reaction of the compound (III) with a silyl compound such as bis(trimethylsilyl)acetamide, mono(trimethylsilyl)acetamide, bis(trimethylsilyl)urea or the like; a derivative formed by reaction of the compound (III) with phosphorus trichloride or phosgene, and the like.

Suitable salts of the compound (III) and its reactive derivative can be referred to the acid addition salts as exemplified for the compound (I).

Suitable reactive derivative at the carboxy group of the compound (II) may include an acid halide, an acid anhydride, an activated amide, an activated ester, and the like. Suitable examples of the reactive derivatives may be an acid chloride; an acid azide; a mixed acid anhydride with acid such as substituted phosphoric acid [e.g. dialkylphosphoric acid, phenylphosphoric acid, diphenylphosphoric acid, dibenzylphosphoric acid, halogenated phosphoric acid, etc.], dialkylphosphorous acid, sulfurous acid, thiosulfuric acid, sulfuric acid, sulfonic acid [e.g. methanesulfonic acid, etc.], aliphatic carboxylic acid [e.g. acetic acid, propionic acid, butyric acid, isobutyric acid, pivalic acid, pentanoic acid, isopentanoic acid, 2-ethylbutyric acid, trichloroacetic acid, etc.] or aromatic carboxylic acid [e.g. benzoic acid, etc.]; a symmetrical acid anhydride; an activated amide with imidazole, 4-substituted imidazole, dimethylpyrazole, triazole or tetrazole; or an activated ester [e.g. cyanomethyl ester, methoxymethyl ester, dimethyliminomethyl  $[(\text{CH}_3)_2\text{N}^+=\text{CH}-]$  ester, vinyl ester,



propargyl ester, p-nitrophenyl ester, 2,4-dinitrophenyl ester, trichlorophenyl ester, pentachlorophenyl ester, mesylphenyl ester, phenylazophenyl ester, phenyl thioester, p-nitrophenyl thioester, p-cresyl thioester, 5 carboxymethyl thioester, pyranyl ester, pyridyl ester, piperidyl ester, 8-quinolyl thioester, etc.], or an ester with a N-hydroxy compound [e.g. N,N-dimethylhydroxylamine, 1-hydroxy-2-(1H)-pyridone, N-hydroxysuccinimide, N-hydroxyphthalimide, 1-hydroxy-1H-benzotriazole, etc.], 10 and the like. These reactive derivatives can optionally be selected from them according to the kind of the compound (II) to be used.

Suitable salts of the compound (II) and its reactive derivative may be the same as those for the compound (I).

15 The reaction is usually carried out in a conventional solvent such as water, alcohol [e.g. methanol, ethanol, etc.], acetone, dioxane, acetonitrile, chloroform, methylene chloride, ethylene chloride, tetrahydrofuran, ethyl acetate, N,N-dimethylformamide, pyridine or any 20 other organic solvent which does not adversely influence the reaction. These conventional solvent may also be used in a mixture with water.

In this reaction, when the compound (II) is used in a free acid form or its salt form, the reaction is 25 preferably carried out in the presence of a conventional condensing agent such as N,N'-dicyclohexylcarbodiimide; N-cyclohexyl-N'-morpholinoethylcarbodiimide; N-cyclohexyl-N'-(4-diethylaminocyclohexyl)carbodiimide; N,N'-diethylcarbodiimide, N,N'-diisopropylcarbodiimide; 30 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (WSCD); N,N'-carbonylbis(2-methylimidazole); pentamethyleneketene-N-cyclohexylimine; diphenylketene-N-cyclohexylimine, ethoxyacetylene; 1-alkoxy-1-chloroethylene, trialkyl phosphite; 35 ethyl polyphosphate; isopropyl polyphosphate;

phosphorus oxychloride (phosphoryl chloride);  
phosphorus trichloride; diphenylphosphorylazide;  
thionyl chloride; oxalyl chloride; lower alkyl haloformate  
[e.g. ethyl chloroformate, isopropyl chloroformate, etc.];  
5 triphenylphosphine; 2-ethyl-7-hydroxybenzisoxazolium salt;  
2-ethyl-5-(m-sulfophenyl)isoxazolium hydroxide  
intramolecular salt; N-hydroxybenzotriazole (HOBT);  
1-(p-chlorobenzenesulfonyloxy)-6-chloro-1H-benzotriazole;  
so-called Vilsmeier reagent prepared by the reaction of  
10 N,N-dimethylformamide with thionyl chloride, phosgene,  
trichloromethyl chloroformate, phosphorus oxychloride,  
etc.; or the like.

The reaction may also be carried out in the presence  
of an inorganic or organic base such as an alkali metal  
15 bicarbonate, tri(lower)alkylamine (e.g. triethylamine,  
etc.), pyridine, N-(lower)alkylmorpholine,  
N,N-di(lower)alkylbenzylamine, N,N-diisopropyl-N-  
ethylamine, or the like.

The reaction temperature is not critical, and the  
20 reaction is usually carried out under cooling to warming.

## Process 2

The object compound (I-b) or a salt thereof can be  
prepared by subjecting the compound (I-a) or a salt  
25 thereof to a removal reaction of the phthalimido moiety.

Suitable salts of the compound (I-a) and (I-b) can be  
referred to the ones as exemplified for the compound (I).

This reaction can be carried out by a conventional  
method which can convert the phthalimido moiety to amino  
30 moiety such as reacting with lower alkylamine (e.g.  
methylamine, etc.), reacting with hydrazine or its hydrate  
(e.g. hydrazine monohydrate, etc.), reacting with  
arylhydrazine or its salt (e.g. phenylhydrazine  
hydrochloride, etc.), reducing with a suitable reducing  
35 agent (e.g. sodium borohydride, etc.), reacting with a

combination of sodium sulfide or its hydrate (e.g. sodium sulfide monohydride, etc.) and 1,3-dicyclohexylcarbodiimide (DCC), and the like.

5 This reaction is usually carried out in a conventional solvent which does not adversely influence the reaction such as water, alcohol (e.g. methanol, ethanol, propanol, etc.), dioxane, tetrahydrofuran, acetic acid, buffer solution (e.g. phosphate buffer, etc.), and the like, or a mixture thereof.

10 The reaction temperature is not critical and the reaction is usually carried out under from cooling to heating.

### Process 3

15 The object compound (I-c) or a salt thereof can be prepared by alkylating the amino group of a compound (I-b) or a salt thereof.

Suitable salts of the compounds (I-b) and (I-c) can be referred to the ones as exemplified for the compound (I).

20

Suitable alkylating agent used in this reaction may include a conventional one which is capable of alkylating amino group to alkylamino group such as dialkyl sulfate (e.g. dimethyl sulfate, diethyl sulfate, etc.), alkyl sulfonate (e.g. methyl sulfonate, etc.), alkyl halide (e.g. methyl iodide, ethyl iodide, propyl bromide, etc.), diazoalkanes (e.g. diazomethane, diazoethane, etc.), a combination of formaldehyde and a suitable reducing agent (e.g. sodium cyanoborohydride, etc.), and the like.

25

30

This reaction is preferably carried out in the presence of an inorganic or organic base such as those given in the explanation of the Process 1.

35 Further, this reaction is usually carried out in a

conventional solvent which does not adversely influence the reaction such as water, acetone, dichloromethane, methanol, ethanol, propanol, pyridine, N,N-dimethylformamide, or a mixture thereof.

5       The reaction temperature is not critical and the reaction is usually carried out under from cooling to warming.

#### Process 4

10       The object compound (I-e) or a salt thereof can be prepared by acylating the compound (I-d) or a salt thereof.

      Suitable acylating agent used in this reaction may be a conventional acylating agent which is capable of  
15       introducing the acyl group as mentioned before such as carboxylic acid, carbonic acid, sulfonic acid and their reactive derivative, for example, an acid halide, an acid anhydride, an activated amide, an activated ester, and the like. Preferable examples of such reactive derivative may  
20       include acid chloride, acid bromide, a mixed acid anhydride with an acid such as substituted phosphoric acid (e.g. dialkylphosphoric acid, phenylphosphoric acid, diphenylphosphoric acid, dibenzylphosphoric acid, halogenated phosphoric acid, etc.), dialkylphosphorous  
25       acid, sulfurous acid, thiosulfuric acid, sulfuric acid, alkyl carbonate (e.g. methyl carbonate, ethyl carbonate, propyl carbonate, etc.), aliphatic carboxylic acid (e.g. pivalic acid, pentanoic acid, isopentanoic acid, 2-ethylbutyric acid, trichloroacetic acid, etc.), aromatic  
30       carboxylic acid (e.g. benzoic acid, etc.), a symmetrical acid anhydride, an activated acid amide with a heterocyclic compound containing imino function such as imidazole, 4-substituted imidazole, dimethylpyrazole, triazole and tetrazole, an activated ester (e.g.  
35       p-nitrophenyl ester, 2,4-dinitrophenyl ester,

trichlorophenyl ester, pentachlorophenyl ester,  
mesylphenyl ester, phenylazophenyl ester, phenyl  
thioester, p-nitrophenyl thioester, p-cresyl thioester,  
carboxymethyl thioester, pyridyl ester, piperidinyl ester,  
5 8-quinolyl thioester, or an ester with a N-hydroxy  
compound such as N,N-dimethylhydroxylamine,  
1-hydroxy-2-(1H)-pyridone, N-hydroxysuccinimide,  
N-hydroxyphthalimide, 1-hydroxybenzotriazole, 1-hydroxy-6-  
chlorobenzotriazole, etc.), isocyanate compound such as  
10 phenyl isocyanate, etc., and the like.

This reaction can be carried out in the presence of  
an organic or inorganic base such as alkali metal (e.g.  
lithium, sodium, potassium, etc.), alkaline earth metal  
15 (e.g. calcium, etc.), alkali metal hydride (e.g. sodium  
hydride, etc.), alkaline earth metal hydride (e.g. calcium  
hydride, etc.), alkali metal hydroxide (e.g. sodium  
hydroxide, potassium hydroxide, etc.), alkali metal  
carbonate (e.g. sodium carbonate, potassium carbonate,  
20 etc.), alkali metal bicarbonate (e.g. sodium bicarbonate,  
potassium bicarbonate, etc.), alkali metal alkoxide (e.g.  
sodium methoxide, sodium ethoxide, potassium tert-  
butoxide, etc.), alkali metal alkanoic acid (e.g. sodium  
acetate, etc.), trialkylamine (e.g. triethylamine, etc.),  
25 pyridine compound (e.g. pyridine, lutidine, picoline,  
4-dimethylaminopyridine, etc.), quinoline, and the like.

In case that the acylating agent is used in a free  
form or its salt in this reaction, the reaction is  
30 preferably carried out in the presence of a condensing  
agent such as a carbodiimide compound [e.g.  
N,N'-dicyclohexylcarbodiimide,  
N-cyclohexyl-N'-(4-diethylaminocyclohexyl)carbodiimide,  
N,N'-diethylcarbodiimide, N,N'-diisopropylcarbodiimide,  
35 N-ethyl-N'-(3-dimethylaminopropyl)carbodiimide, etc.],

a ketenimine compound (e.g. N,N'-carbonylbis(2-methylimidazole), pentamethyleneketene-N-cyclohexylimine, diphenylketene-N-cyclohexylimine, etc.);  
an olefinic or acetylenic ether compounds (e.g. ethoxyacetylene,  $\beta$ -chlorovinylethyl ether), a sulfonic acid ester of N-hydroxybenzotriazole derivative [e.g. 1-(4-chlorobenzenesulfonyloxy)-6-chloro-1H-benzotriazole, etc.], a combination of trialkylphosphite or triphenylphosphine and carbon tetrachloride, disulfide or diazenedicarboxylate (e.g. diethyl diazenedicarboxylate, etc.), a phosphorus compound (e.g. ethyl polyphosphate, isopropyl polyphosphate, phosphoryl chloride, phosphorus trichloride, etc.), thionyl chloride, oxalyl chloride, N-ethylbenzisoxazolium salt, N-ethyl-5-phenylisoxazolium-3-sulfonate, a reagent (referred to a so-called "Vilsmeier reagent") formed by the reaction of an amide compound such as N,N-di(lower)alkylformamide (e.g. dimethylformamide, etc.), N-methylformamide or the like, with a halogen compound such as thionyl chloride, phosphoryl chloride, phosgene or the like.

The reaction is usually carried out in a conventional solvent which does not adversely influence the reaction such as water, acetone, dichloromethane, alcohol (e.g. methanol, ethanol, etc.), tetrahydrofuran, pyridine, N,N-dimethylformamide, etc., or a mixture thereof.

The reaction temperature is not critical and the reaction is usually carried out under from cooling to heating.

#### Process 5

The object compound (I-g) or a salt thereof can be prepared by subjecting the compound (I-f) or a salt thereof to a removal reaction of the hydroxy-protective group.

Suitable salts of the compounds (I-f) and (I-g) can be referred to the ones as exemplified for the compound (I).

The present reaction is usually carried out by a conventional method such as hydrolysis, reduction, and the like.

(i) Hydrolysis :

Hydrolysis is preferably carried out in the presence of a base or an acid. Suitable base may include an alkali metal hydroxide (e.g. sodium hydroxide, potassium hydroxide, etc.), an alkaline earth metal hydroxide (e.g. magnesium hydroxide, calcium hydroxide, etc.), alkali metal hydride (e.g. sodium hydride, potassium hydride, etc.), alkaline earth metal hydride (e.g. calcium hydride, etc.), alkali metal alkoxide (e.g. sodium methoxide, sodium ethoxide, potassium t-butoxide, etc.), an alkali metal carbonate (e.g. sodium carbonate, potassium carbonate, etc.), an alkaline earth metal carbonate (e.g. magnesium carbonate, calcium carbonate, etc.), an alkali metal bicarbonate (e.g. sodium bicarbonate, potassium bicarbonate, etc.), and the like.

Suitable acid may include an organic acid (e.g. formic acid, acetic acid, propionic acid, trifluoroacetic acid, benzenesulfonic acid, p-toluenesulfonic acid, etc.) and an inorganic acid (e.g. hydrochloric acid, hydrobromic acid, sulfuric acid, phosphoric acid, etc.). The acidic hydrolysis using trifluoroacetic acid is usually accelerated by addition of cation trapping agent (e.g. phenol, anisole, etc.).

In case that the hydroxy-protective group is tri(lower)alkylsilyl, the hydrolysis can be carried out in the presence of tri(lower)alkylammonium fluoride (e.g. tributylammonium fluoride, etc.).

This reaction is usually carried out in a conventional solvent which does not adversely influence the reaction such as water, dichloromethane, alcohol (e.g. methanol, ethanol, etc.), tetrahydrofuran, dioxane, acetone, etc., or a mixture thereof. A liquid base or acid can be also used as the solvent.

The reaction temperature is not critical and the reaction is usually carried out under from cooling to heating.

(ii) Reduction :

The reduction method applicable for this removal reaction may include, for example, reduction by using a combination of a metal (e.g. zinc, zinc amalgam, etc.) or a salt of chrome compound (e.g. chromous chloride, chromous acetate, etc.) and an organic or inorganic acid (e.g. acetic acid, propionic acid, hydrochloric acid, sulfuric acid, etc.); and conventional catalytic reduction in the presence of a conventional metallic catalyst such as palladium catalysts (e.g. spongy palladium, palladium black, palladium oxide, palladium on carbon, palladium hydroxide on carbon, colloidal palladium, palladium on barium sulfate, palladium on barium carbonate, etc.), nickel catalysts (e.g. reduced nickel, nickel oxide, Raney nickel, etc.), platinum catalysts (e.g. platinum plate, spongy platinum, platinum black, colloidal platinum, platinum oxide, platinum wire, etc.), and the like.

In case that the catalytic reduction is applied, the reaction is preferably carried out in the presence of an acid (e.g. formic acid, etc.).

This reaction is usually carried out in a conventional solvent which does not adversely influence the reaction such as water, alcohol (e.g. methanol, ethanol, propanol, etc.), dioxane, tetrahydrofuran, acetic



acid, buffer solution (e.g. phosphate buffer, etc.), and the like, or a mixture thereof.

The reaction temperature is not critical and the reaction is usually carried out under from cooling to warming.

In case that the hydroxy-protective group is allyloxycarbonyl group, it can be deprotected by hydrogenolysis using a palladium compound.

Suitable palladium compound used in this reaction may be palladium on carbon, palladium hydroxide on carbon, palladium chloride, a palladium-ligand complex such as tetrakis(triphenylphosphine)palladium(0), bis(dibenzylideneacetone)palladium(0), di[1,2-bis(diphenyl phosphino)ethane]palladium(0), tetrakis(triphenylphosphite)palladium(0), tetrakis(triethyl phosphite)palladium(0), and the like.

This reaction can preferable be carried out in the presence of a scavenger of allyl group generated in situ, such as amine (e.g. morpholine, N-methylaniline, etc.), an activated methylene compound (e.g. dimedone, benzoylacetate, 2-methyl-3-oxovaleric acid, etc.), a cyanohydrin compound (e.g.  $\alpha$ -tetrahydropyranyloxybenzylcyanide, etc.), lower alkanolic acid or a salt thereof (e.g. formic acid, acetic acid, ammonium formate, sodium acetate, etc.), N-hydroxysuccinimide, and the like.

This reaction can be carried out in the presence of a base such as lower alkylamine (e.g. butylamine, triethylamine, etc.), pyridine, and the like.

When palladium-ligand complex is used in this reaction, the reaction can preferably be carried out in the presence of the corresponding ligand (e.g. triphenylphosphine, triphenyl phosphite, triethyl phosphite, etc.).

This reaction is usually carried out in a conventional solvent which does not adversely influence

the reaction such as water, methanol, ethanol, propanol, dioxane, tetrahydrofuran, acetonitrile, chloroform, dichloromethane, dichloroethane, ethyl acetate, etc., or a mixture thereof.

5        The reaction temperature is not critical and the reaction is usually carried out under from cooling to warming.

      The reaction can be selected according to the kind of hydroxy-protective group to be eliminated.

10

#### Process 6

      The compound (I-i) or a salt thereof can be prepared by reacting the compound (I-h) or a salt thereof with the compound (IV) or its reactive derivative at the amino  
15        group, or a salt thereof.

      Suitable salts of the compounds (I-g) and (I-h) may be the same as those for the compound (I).

      Suitable salts of the compound (IV) may be the same acid addition salts as exemplified for the compound (I).

20

      Suitable reactive derivative of the compound (IV) can be referred to the ones as exemplified for the compound (III).

      The reaction is usually carried out in a conventional solvent which does not adversely influence the reaction  
25        such as water, acetone, dioxane, dimethylformamide, dichloromethane, chloroform, pyridine, etc., or a mixture thereof.

      The reaction temperature is not critical and the reaction is usually carried out under from cooling to  
30        warming.

#### Process 7

      The compound (I-k) or a salt thereof can be prepared by subjecting the compound (I-j) or a salt thereof to a  
35        removal reaction of the carboxy-protective group on  $R_B^2$ .

Suitable salts of the compounds (I-k) and (I-j) may be the same as those for the compound (I).

The reaction is usually carried out in substantially the same manner as those for the process 5, and therefore the reagents to be used and the reaction condition (e.g. solvent, reaction temperature, etc.) can be referred to those of the Process 5.

#### 10     Process 8

The compound (I-m) or a salt thereof can be prepared by subjecting the compound (I-l) or a salt thereof to a removal reaction of the amino-protective group on  $R_D^2$ .

Suitable salts of the compounds (I-l) and (I-m) may be the same as those for the compound (I).

The reaction is usually carried out in substantially the same manner as those for the Process 5, and therefore the reagents to be used and the reaction condition (e.g. solvent, reaction temperature, etc.) can be referred to those of the Process 5.

#### Process 9

The compound (I-o) or a salt thereof can be prepared by subjecting the compound (I-n) or a salt thereof to a removal reaction of the hydroxy-protective group on  $R_F^2$ .

Suitable salts of the compounds (I-n) and (I-o) may be the same as those for the compound (I).

The reaction is usually carried out in substantially the same manner as those for the Process 5, and therefore the reagents to be used and the reaction condition (e.g. solvent, reaction temperature, etc.) can be referred to those of the Process 5.

Process 10

The compound (I-q) or a salt thereof can be prepared by reacting the compound (I-p) or a salt thereof with lower alkylamine.

5        Suitable salts of the compounds (I-p) and (I-q) may be the same as those for the compound (I).

10        The reaction is usually carried out in a conventional solvent which does not adversely influence the reaction such as water, acetone, dichloromethane, alcohol (e.g. methanol, ethanol, etc.), tetrahydrofuran, pyridine, N,N-dimethylformamide, etc., or a mixture thereof.

15        The reaction temperature is not critical and the reaction is usually carried out under from cooling to warming.

20        The compounds obtained by the above processes can be isolated and purified by a conventional method such as pulverization, recrystallization, column chromatography, reprecipitation, or the like.

      The object compound (I) can be transformed into its salt in a conventional manner.

25        It is to be noted that the compound (I) and the other compounds may include one or more stereoisomers due to asymmetric carbon atoms, and all of such isomers and mixture thereof are included within the scope of this invention.

30        Collagenases initiate the degradation of collagen in vertebrates and in addition to their normal function in the metabolism of connective tissue and wound healing, it has been implicated in a number of pathological conditions such as joint destruction in rheumatoid arthritis,  
35        periodontal disease, corneal ulceration, tumor metastasis,

osteoarthritis, decubitus restenosis after the percutaneous transluminal coronary angioplasty, osteoporosis, proriasis, chronic active hepatitis, autoimmune keratitis, and the like, and therefore the  
5 compound of the present invention is useful for treating and/or preventing such pathological conditions.

For therapeutic purpose, the peptide compound (I) and a pharmaceutically acceptable salt thereof of the present  
10 invention can be used in a form of pharmaceutical preparation containing one of said compounds, as an active ingredient, in admixture with a pharmaceutically acceptable carrier such as an organic or inorganic solid or liquid excipient suitable for oral, parenteral or  
15 external administration. The pharmaceutical preparations may be capsules, tablets, dragees, granules, solution, suspension, emulsion, sublingual tablet, suppositories, ointment, and the like. If desired, there may be included in these preparations, auxiliary substances, stabilizing  
20 agents, wetting or emulsifying agents, buffers and other commonly used additives.

While the dosage of the compound (I) will vary depending upon the age and condition of the patient, in  
25 the case of intravenous administration, a daily dose of 0.01 - 100 mg of the active ingredient per kg weight of a human being, in the case of intramuscular administration, a daily dose of 0.05 - 100 mg of the same per kg weight of a human being, in case of oral administration, a daily  
30 dose of 0.1 - 100 mg of the same per kg weight of a human being is generally given for the treatment of collagenase-mediated diseases.

In order to illustrate the usefulness of the object  
35 compound (I), the pharmacological test data of a

representative compound of the compound (I) are shown in the following.

### Inhibitory activity of collagenase

5

#### 1. Test method

Human collagenase was prepared from the culture medium of human skin fibroblast stimulated by interleukin-1 $\beta$  (1 ng/ml). Latent collagenase was  
10 activated by incubation with trypsin (200  $\mu$ g/ml) at 37°C for 60 minutes and the reaction was stopped by adding soybean trypsin inhibitor (800  $\mu$ g/ml). Collagenase activity was determined using FITC-labeled calf skin type I collagen. FITC-collagen (2.5 mg/ml) was incubated at  
15 37°C for 120 minutes with the activated collagenase and test compound in 50 mM Tris buffer (containing 5 mM CaCl<sub>2</sub>, 200 mM NaCl and 0.02% NaN<sub>3</sub>, pH 7.5). After stopping the enzyme reaction by adding equal volume of 70% ethanol-200 mM Tris buffer (pH 9.5), the reaction mixture was  
20 centrifuged, and collagenase activity was estimated by measuring the fluorescence intensity of supernatant at 495 nm (excitation) and 520 nm (emission).

#### 2. Test Compound

25

Compound A (The compound of Example 12-4)

#### 3. Test Result

30

### Inhibitory activity

Test Compound	IC <sub>50</sub> (nM)
Compound A	1.5

35

The following examples are given for purpose of illustrating the present invention in detail.

5

In these examples, there are employed the following abbreviations in addition to the abbreviations adopted by the IUPAC-IUB.

10	DEF	:	dimethylformamide
	DMSO	:	dimethyl sulfoxide
	HOBt	:	N-hydroxybenzotriazole
	WSCD	:	1-ethyl-3-(3-dimethylaminopropyl)- carbodiimide

15

The following Preparations and Examples are given for the purpose of illustrating the present invention in more detail.

20

25

30

Preparation 1

Thionyl chloride (73 ml) was added dropwise into absolute ethanol (300 ml) at 0°C. After L-4-pyridylalanine D-tartrate (31.6 g) was added portionwise, the suspension was slowly heated to reflux and stirred overnight. The solvent was evaporated to one third volume in vacuo, and was triturated with ethyl acetate to give L-4-pyridylalanine ethyl ester dihydrochloride (24.7 g).

$[\alpha]_D^{25} = +24.0^\circ$  (c 0.99, H<sub>2</sub>O)

mp : 185-186°C

NMR (D<sub>2</sub>O,  $\delta$ ) : 3.60 (1H, dd, J=14, 7Hz), 3.68 (1H, dd, J=14, 8Hz), 3.82 (3H, s), 4.71 (1H, dd, J=8, 7Hz), 8.08 (2H, d, J=7Hz), 8.80 (2H, d, J=7Hz)

HPLC : 8.4 minutes(min.) (Crownpak CR(+),

4 mm $\phi$  x 15 cm, pH 1.0 HClO<sub>4</sub>aq., 210 nm, flow rate 0.5 ml/min., at R.T.)

MASS : M+H=181

Preparation 2

To a solution of (3R)-3-carboxy-5-methyl-2-(phthalimidomethyl)hexanoic acid tert-butyl ester (5.00 g) in DMF (50 ml) were added HOBT (2.08 g), WSCD (2.39 g), L-4-pyridylalanine methyl ester dihydrochloride (3.90 g), and N,N-diisopropyl-N-ethylamine (4.03 g) at 0°C. The mixture was stirred at room temperature for 15 hours. The reaction mixture was poured into brine, and was extracted with ethyl acetate. The extract was washed with saturated ammonium chloride, saturated sodium bicarbonate, and brine successibly. The organic layer was dried over magnesium sulfate (MgSO<sub>4</sub>) and was concentrated in vacuo. The residue was purified by silica gel column chromatography (eluent : ethyl acetate) to give N-[(2R)-4-tert-butoxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methyl ester (5.63 g).

mp : 66-69°C



NMR (CDCl<sub>3</sub>,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 1.11 (1H, ddd, J=13, 9, 4Hz), 1.27 (9H, s), 1.50 (1H, m), 1.71 (1H, ddd, J=13, 9, 4Hz), 2.65 (1H, m), 2.92 (1H, m), 3.11 (1H, dd, J=14, 8Hz), 3.28 (1H, dd, J=14, 6Hz), 3.58-3.64 (2H, m), 3.75 (3H, s), 5.00 (1H, ddd, J=8, 7.5, 6Hz), 6.88 (1H, d, J=7.5Hz), 7.18 (2H, d, J=7Hz), 7.69-7.77 (2H, m), 7.81-7.90 (2H, m), 8.49 (2H, d, J=7Hz)

HPLC : 9.3, 9.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=552

### Preparation 3

To a solution of N-[(2R)-4-tert-butoxycarbonyl-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methyl ester (5.52 g) in dichloromethane (30 ml) was added trifluoroacetic acid (30 ml) at 0°C. The reaction mixture was stirred at room temperature for 1.5 hours. After the solvent was concentrated in vacuo, the residue was triturated with ethyl acetate to give N-[(2R,3R)-4-hydroxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methyl ester trifluoroacetate (3.50 g).

$[\alpha]_D^{25} = -14.7^\circ$  (c 0.30, 1N-HCl aq.)

mp : 190-194°C

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.78 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, ddd, J=13, 11, 2Hz), 1.36 (1H, m), 1.51 (1H, ddd, J=13, 11, 2Hz), 2.43-2.57 (1H, m), 2.62-2.76 (2H, m), 3.10 (1H, dd, J=14, 12Hz), 3.40 (1H, dd, J=14, 5Hz), 3.50 (1H, m), 3.65 (3H, s), 4.89 (1H, ddd, J=12, 8, 5Hz), 7.75 (2H, d, J=6Hz), 7.82-7.92 (4H, m), 8.62 (2H, d, J=6Hz), 8.72 (1H, d, J=8Hz)

HPLC : 3.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0

ml/min., at R.T.)

MASS : M+H=496

#### Preparation 4

5 Thionyl chloride (73 ml) was added dropwise into absolute ethanol (300 ml) at 0°C. After L-4-pyridylalanine D-tartrate (31.6 g) was added portionwise, the suspension was slowly heated to reflux and stirred overnight. The solvent was evaporated to one third volume in vacuo, and was  
10 triturated with ethyl acetate to give L-4-pyridylalanine ethyl ester dihydrochloride (24.7 g).

$[\alpha]_D^{24} = +22.6^\circ$  (c 0.54, 1N-HCl aq.)

mp : 160-166°C

15 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 1.14 (3H, t, J=7Hz), 3.47 (1H, dd, J=15, 7.5Hz), 3.55 (1H, dd, J=15, 7Hz), 4.15 (2H, m), 4.55 (1H, br), 8.10 (2H, d, J=7Hz), 8.91 (2H, d, J=7Hz), 8.98 (1H, br)

HPLC : 12.3 min. (Crownpak CR(+), 4 mm $\phi$  x 15 cm, pH 1.0 HClO<sub>4</sub> aq., 210 nm, flow rate 0.6 ml/min., at R.T.)

20 MASS : M+H=195

#### Preparation 5

L-4-Pyridylalanine ethyl ester dihydrochloride (24.3 g) was dissolved in H<sub>2</sub>O and the pH was adjusted to 8-9 by the  
25 addition of sodium hydrogen carbonate. The solution was saturated with sodium chloride and was extracted with chloroform. The extract was dried over MgSO<sub>4</sub> and concentrated to dryness to give L-4-pyridylalanine ethyl ester as a pale yellow oil (15.6 g).

30 NMR (CDCl<sub>3</sub>,  $\delta$ ) : 1.23 (3H, t, J=7Hz), 1.49 (2H, br), 2.86 (1H, dd, J=14, 7.5Hz), 3.05 (1H, dd, J=14, 6Hz), 3.73 (1H, dd, J=7.5, 6Hz), 4.17 (2H, q, J=7Hz), 7.15 (2H, d, J=7Hz), 8.53 (2H, d, J=7Hz)

HPLC : 11.2 min. (Crownpak CR(+), 4 mm $\phi$  x 15 cm, pH 1.0 HClO<sub>4</sub> aq., 210 nm, flow rate 0.6 ml/min., at R.T.)  
35

MASS : M+H=195

#### Preparation 6

L-4-Pyridylalanine ethyl ester (14.79 g) was dissolved into a solution of 20% methylamine in methanol (60 ml), and the mixture was stirred for 4 hours at room temperature. The solution was evaporated to give L-4-pyridylalanine methylamide (12.59 g).

$[\alpha]_D^{24} = +20.7^\circ$  (c 0.55, MeOH)

mp : 48-52°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 1.71 (2H, br), 2.57 (3H, d, J=5Hz), 2.62 (1H, dd, J=14, 8Hz), 2.90 (1H, dd, J=14, 5Hz), 3.38 (1H, dd, J=8, 5Hz), 7.21 (2H, d, J=6Hz), 7.82 (1H, q, J=5Hz), 8.44 (2H, d, J=6Hz)

HPLC : 11.2 min. (Crownpak CR(+), 4 mm $\phi$  x 15 cm, pH 1.0 HClO<sub>4</sub>aq., 210 nm, flow rate 0.6 ml/min., at R.T.)

MASS : M+H=180

#### Preparation 7

To a solution of (3R)-3-carboxy-5-methyl-2-(phthalimidomethyl)hexanoic acid tert-butyl ester (10.13 g) in DMF (100 ml) were added HOBT (3.87 g), WSCD·HCl (5.49 g), and L-4-pyridylalanine methylamine (4.89 g) at 0°C. The mixture was stirred at room temperature for 3 hours. The reaction mixture was poured into brine, and was extracted with ethyl acetate. The extract was washed with saturated ammonium chloride, saturated sodium bicarbonate, and brine successively. The organic layer was dried over MgSO<sub>4</sub> and concentrated in vacuo. The residue was purified by silica gel column chromatography (eluent : methanol/ethyl acetate = 1/10) to give N-[(2R)-4-tert-butoxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methylamide (13.8 g).

mp : 92-95°C

NMR (CDCl<sub>3</sub>,  $\delta$ ) : 0.67-0.88 (7H, m), 1.13 (1H, m), 1.28

(9Hx3/4, s), 1.31 (9Hx1/4, s), 1.65 (1H, m), 2.50 (1Hx1/4, m), 2.62 (1Hx3/4, m), 2.77 (3Hx3/4, d, J=5Hz), 2.80 (3Hx1/4, d, J=5Hz), 2.90 (1H, m), 3.11 (1H, m), 3.27 (1H, m), 3.52-3.60 (2H, m), 4.72 (1Hx1/4, m), 4.78 (1Hx3/4, m), 6.31 (1Hx3/4, m), 6.48 (1Hx1/4, m), 6.94 (1Hx3/4, d, J=8Hz), 7.14 (1Hx1/4, d, J=8Hz), 7.20 (2H, d, J=7Hz), 7.68-7.78 (2H, m), 7.80 (2H, m), 8.47 (2Hx3/4, d, J=7Hz), 8.50 (2Hx1/4, d, J=7Hz)

10 HPLC : 6.0, 6.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=551

15 Preparation 8

N-[(2R)-4-Hydroxy-2-isobutyl-3-(phthalimidomethyl)-succinyl]-L-4-pyridylalanine methylamide trifluoroacetate was obtained in substantially the same manner as that of Preparation 3.

20 mp : 180-185°C

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.72-0.87 (6H, m), 0.92 (1H, m), 1.33 (1H, m), 1.49 (1H, m), 2.47-2.70 (3H, m), 2.59 (3Hx1/4, d, J=5Hz), 2.62 (3Hx3/4, d, J=5Hz), 2.97 (1H, dd, J=14, 11.5Hz), 3.17 (1H, dd, J=14, 5Hz), 3.48 (1H, m), 4.59 (1Hx1/4, m), 4.75 (1Hx3/4, m), 7.68 (2Hx3/4, d, J=7Hz), 7.72 (2Hx1/4H, d, J=7Hz), 7.80-7.91 (4H, m), 7.96 (1H, m), 8.40 (1Hx1/4, d, J=8Hz), 8.54 (1Hx3/4, d, J=8Hz), 8.57 (2Hx3/4, d, J=8Hz), 8.72 (2Hx1/4, d, J=7Hz)

30 HPLC : 5.1, 8.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=495

35 Preparation 9

L-2-Pyridylalanine methyl ester dihydrochloride was obtained in substantially the same manner as that of Preparation 4.

$$[\alpha]_D^{22} = +28.3^\circ \text{ (c 1.03, H}_2\text{O)}$$

mp : 209-213°C

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 3.58 (2H, d, J=7Hz), 3.67 (3H, s), 4.62 (1H, br), 7.70 (1H, m), 7.80 (1H, br d, J=7.5Hz), 8.23 (1H, m), 8.71 (1H, d, J=5Hz), 8.91 (2H, br)

HPLC : 10.4 min. (Crownpak CR(+), 4 mm $\phi$  x 15 cm, pH 1.0 HClO<sub>4</sub>aq., 210 nm, flow rate 0.5 ml/min., at R.T.)

MASS : M+H=181

#### Preparation 10

L-2-Pyridylalanine methyl ester dihydrochloride (10.0 g) was dissolved in saturated sodium hydrogen carbonate (10 ml). The solution was saturated with sodium chloride and extracted with chloroform (300 ml x 3). After the extract was concentrated to dryness, the residue was dissolved in 40% methylamine in methanol (30 ml). The mixture was stirred for 1 hour at room temperature. The solution was evaporated to give L-2-pyridylalanine methylamide (7.0 g).

R<sub>f</sub> : 0.19 (methanol/chloroform = 1/5)

#### Preparation 11

N-[(2R,3R)-4-tert-Butoxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine methyl ester was obtained in substantially the same manner as that of Preparation 7.

R<sub>f</sub> : major isomer 0.42, minor isomer 0.46  
(methanol/chloroform = 1/10)

#### Preparation 12

N-[(2R)-4-tert-Butoxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine methylamide (14.0 g) was

dissolved in trifluoroacetic acid (30 ml) at 0°C. The reaction mixture was stirred at room temperature for 0.5 hour. After the solvent was concentrated in vacuo, the residue was poured into saturated sodium hydrogen carbonate.

5 The solution was extracted with chloroform. The organic layer was concentrated in vacuo and the residue was triturated with ethyl acetate to give N-[(2R)-4-hydroxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine methylamide (3.50 g).

10 HPLC : 3.7, 4.8 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

#### Preparation 13

15 To a stirred suspension of glycine methyl ester hydrochloride (1.70 g) in dichloromethane (15 ml) was added triethylamine (3.01 g) and phenyl chloroformate (2.12 g) at 0°C. The mixture was stirred at 0°C for 30 minutes. The reaction mixture was poured into water and was extracted with  
20 dichloromethane. The organic layer was washed with brine, dried over anhydrous magnesium sulfate and concentrated in vacuo. The residue was purified by a silica gel column chromatography (ethyl acetate:hexane = 1:1) to give  
N-phenoxy-carbonylglycine methyl ester (1.37 g) as a white  
25 crystal.

mp : 46-47°C

NMR (CDCl<sub>3</sub>, δ) : 3.79 (3H, s), 4.07 (2H, d, J=7Hz),  
5.52 (1H, br), 7.13 (2x1H, d, J=7.5Hz), 7.20 (1H,  
dd, J=7.5, 7.5Hz), 7.36 (2x1H, dd, J=7.5, 7.5Hz)

30 MASS : M+H=210

#### Preparation 14

N-[(2R)-4-tert-Butoxy-2-isobutyl-3-phthalimidomethylsuccinyl]-L-3-pyridylalanine methyl ester  
35 was obtained in substantially the same manner as that of

## Preparation 7.

mp : 65-68°C

NMR (CDCl<sub>3</sub>,  $\delta$ ) : 0.75-0.90 (6H, m), 1.10 (1H, ddd, J=11, 11, 3Hz), 1.27 (3x3H, s), 1.50 (1H, m), 1.70 (1H, m), 2.67 (1H, m), 2.90 (1H, m), 3.13 (1H, dd, J=14, 8Hz), 3.27 (1H, dd, J=14, 6Hz), 3.52 (1H, dd, J=14, 7Hz), 3.69 (1H, dd, J=14, 5Hz), 3.74 (3H, s), 4.98 (1H, m), 6.96 (1H, dd, J=14, 5Hz), 7.22 (1H, dd, J=7.5, 5Hz), 7.62 (1H, m), 7.68-7.76 (2H, m), 7.80 (2H, m), 8.40-8.52 (2H, m)

HPLC : 12.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, acetonitrile:water:trifluoroacetic acid (MeCN:H<sub>2</sub>O:TFA) = 35:65:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=552

Preparation 15

N-[(2R,3R)-4-Hydroxy-2-isobutyl-3-phthalimidomethylsuccinyl]-L-3-pyridylalanine methyl ester trifluoroacetate was obtained in substantially the same manner as that of Preparation 8.

 $[\alpha]_D^{25} = -18.5^\circ$  (c 0.17, 1N-HCl aq.)

mp : 174-177°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.77 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, m), 1.35 (1H, m), 1.50 (1H, m), 2.45-2.58 (1H, m), 2.68 (1H, m), 2.79 (1H, dd, J=13, 5Hz), 3.05 (1H, dd, J=13, 11Hz), 3.32 (1H, dd, J=13, 4Hz), 3.54 (1H, dd, J=13, 12Hz), 3.64 (3H, s), 4.79 (1H, ddd, J=11, 8, 4Hz), 7.69 (1H, dd, J=7.5, 6Hz), 7.81-7.91 (4H, m), 8.23 (1H, d, J=7.5Hz), 8.51 (1H, d, J=6Hz), 8.69 (1H, d, J=8Hz), 8.73 (1H, s)

HPLC : 4.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN : 0.05% TFA aq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=496

Example 1-1)

To a solution of N-[(2R,3R)-4-hydroxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methyl ester  
5 trifluoroacetate (3.26 g) and HOBT (0.87 g) in DMF (30 ml) was added WSCD (1.00 g) at 0°C. After the mixture was stirred for 10 minutes, O-benzylhydroxylamine hydrochloride (1.02 g) and N,N-diisopropyl-N-ethylamine (0.84 g) were  
10 added. The mixture was stirred at room temperature for 15 hours. The mixture was poured into brine (100 ml). The precipitate was collected by filtration and was washed with water and ethyl acetate to give N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-  
15 4-pyridylalanine methyl ester (2.10 g).

$[\alpha]_D^{25} = -52.8^\circ$  (c 0.30, DMSO)

mp : 245-248°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70-0.84 (1H, m), 0.76 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 1.30-1.47 (2H, m),  
20 2.29-2.57 (3H, m), 2.89 (1H, dd, J=14, 12Hz), 3.20 (1H, dd, J=14, 4Hz), 3.45 (1H, m), 3.64 (3H, s), 4.25 (1H, d, J=12Hz), 4.54 (1H, d, J=12Hz), 4.77 (1H, ddd, J=12, 8, 4Hz), 7.05 (2H, d, J=7.5Hz), 7.15-7.27 (3H, m), 7.30 (2H, d, J=7Hz), 7.85 (4H, s),  
25 8.28 (2H, d, J=7Hz), 8.64 (1H, d, J=8Hz), 11.06 (1H, s)

HPLC : 9.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

30 MASS : M+H=601

Example 1-2)

To a solution of N-[(2R)-4-hydroxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methylamide  
35 trifluoroacetate (5.18 g) and HOBT (1.27 g) in DMF (50 ml)



was added WSCD (1.46 g) at 0°C. After the mixture was stirred for 10 minutes, O-benzylhydroxylamine hydrochloride (1.63 g) and N,N-diisopropyl-N-ethylamine (1.34 g) were added. The mixture was stirred at room temperature for 4 hours. The mixture was poured into brine (100 ml). The precipitate was collected by filtration and was washed with water and ethyl acetate to give N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-4-pyridylalanine methylamide (3.40 g).

10  $[\alpha]_D^{25} = +2.8^\circ$  (c 0.10, DMSO)

mp : 263-269°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70-0.85 (1H, m), 0.73 (3H, d, J=7Hz), 0.81 (3H, d, J=7Hz), 1.22-1.45 (2H, m), 2.21 (1H, ddd, J=13, 3, 2Hz), 2.32 (1H, ddd, J=11, 11, 3Hz), 2.50 (1H, dd, J=13, 11Hz), 2.61 (3H, d, J=5Hz), 2.80 (1H, dd, J=14, 11Hz), 3.00 (1H, dd, J=14, 5Hz), 3.40 (1H, dd, J=13, 11Hz), 4.26 (1H, d, J=12Hz), 4.55 (1H, d, J=12Hz), 4.67 (1H, ddd, J=11, 8, 5Hz), 7.03-7.09 (2H, m), 7.15-7.25 (3H, m), 7.30 (2H, d, J=6Hz), 7.85 (4H, s), 7.90 (1H, d, J=5Hz), 8.23 (2x1H, d, J=6Hz), 8.45 (1H, d, J=8Hz)

20 HPLC : 6.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

25 MASS : M+H=600

#### Example 1-3)

To a solution of N-[(2R)-4-hydroxy-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine methylamide (7.0 g) and HOBT (2.9 g) in DMF (140 ml) was added WSCD (3.3 g) at room temperature. After the mixture was stirred for 10 minutes, O-benzylhydroxylamine hydrochloride (3.4 g) and N,N-diisopropyl-N-ethylamine (5 ml) were added. The mixture was stirred at room temperature for 5 hours. The mixture was poured into ethyl acetate (100 ml). The insoluble solid was

collected by filtration to give N-[(2R)-4-(N-benzyloxyamino)-2-isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine methylamine (3.50 g).

5           HPCL : 9.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
              MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
              ml/min., at R.T.)

Example 2-1)

10           N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-  
              (phthalimidomethyl)succinyl]-L-4-pyridylalanine methyl ester  
              (2.51 g) was dissolved into a solution of 40% methylamine in  
              methanol (50 ml), and the mixture was stirred for 15 hours at  
              room temperature. The solution was evaporated and the  
15           residue was dissolved into 1N-hydrochloric acid. The  
              solution was evaporated again and the residue was triturated  
              with water. The precipitate was filtered off and the  
              filtrate was evaporated. The residue was triturated with  
              methanol - ethyl acetate to give N-[(2R,3R)-3-aminomethyl-4-  
              (N-benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
20           methanamide dihydrochloride (2.22 g).

$[\alpha]_D^{25} = -33.0^\circ$  (c 0.32, 1N-HCl aq.)

              mp : 192-199°C

              NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d,  
                                  J=7Hz), 0.84 (1H, m), 1.25 (1H, m), 1.40 (1H, m),  
25           2.30-2.46 (2H, m), 2.52-2.80 (2H, m), 2.60 (3H, d,  
                                  J=4.5Hz), 3.14 (1H, dd, J=14, 11Hz), 3.28 (1H, dd,  
                                  J=14, 5Hz), 4.67 (1H, ddd, J=11, 8, 5Hz), 4.83 (1H,  
                                  d, J=11Hz), 4.87 (1H, d, J=11Hz), 7.31-7.48 (5H,  
                                  m), 8.00 (2H, d, J=7Hz), 8.11 (2H, br), 8.21 (1H,  
30           q, J=4.5Hz), 8.63 (1H, d, J=8Hz), 8.91 (2H, d,  
                                  J=7Hz)

              MASS : M+H=470

Example 2-2)

35           To a suspension of N-[(2R,3R)-4-(N-benzyloxyamino)-2-

isobutyl-3-(phthalimidomethyl)succinyl]-4-pyridylalanine  
methanamide (484 mg) in ethanol was added hydrazine  
monohydrate (0.5 ml). The mixture was refluxed for 2 hours.  
The solution was evaporated and to the residue was added  
5 chloroform. After the insoluble material was filtered off,  
the filtrate was concentrated in vacuo to give N-[(2R,3R)-3-  
aminomethyl-4-(N-benzyloxyamino)-2-isobutylsuccinyl]-L-4-  
pyridylalanine methanamide (293 mg).

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.74-0.89 (1H,  
m), 0.79 (3H, d, J=7Hz), 1.18-1.38 (2H, m), 1.87-  
2.00 (2H, m), 2.25 (1H, m), 2.41 (1H, m), 2.57 (3H,  
d, J=4.5Hz), 2.80 (1H, dd, J=13, 10Hz), 2.94 (1H,  
dd, J=13, 4Hz), 4.55 (1H, ddd, J=10, 8, 4Hz), 4.78  
15 (2H, s), 7.18-7.43 (7H, m), 7.87 (1H, d, J=4.5Hz),  
8.30 (1H, d, J=8Hz), 8.45 (2H, d, J=7Hz)

MASS : M+H=470

#### Example 2-3)

To a suspension of N-(2R,3R)-4-(N-benzyloxyamino)-2-  
isobutyl-3-(phthalimidomethyl)succinyl]-L-2-pyridylalanine  
20 methanamide (3.5 g) in ethanol was added hydrazine  
monohydrate (3.5 ml). The mixture was refluxed for 30  
minutes. The solution was evaporated and to the residue was  
added chloroform. After the insoluble material was filtered  
25 off, the filtrate was evaporated and triturated with ethyl  
acetate to give N-[(2R,3R)-3-aminomethyl-4-  
(N-benzyloxyamino)-2-isobutylsuccinyl]-L-2-pyridylalanine  
methanamide (1.7 g).

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.73-0.86 (1H,  
m), 0.77 (3H, d, J=7Hz), 1.15-1.40 (2H, m), 1.84-  
1.98 (2H, m), 2.19 (1H, dd, J=13, 10Hz), 2.38 (1H,  
m), 2.55 (3H, d, J=4Hz), 2.95 (1H, dd, J=14, 11Hz),  
3.07 (1H, dd, J=14, 5Hz), 4.71 (1H, ddd, J=11, 8,  
5Hz), 4.77 (2H, s), 7.20 (1H, dd, J=7.5, 5Hz), 7.26  
35 (1H, d, J=7.5Hz), 7.31-7.42 (5H, m), 7.64-7.76 (2H,

m), 8.25 (1H, d, J=7.5Hz), 8.46 (1H, br d, J=5Hz)

MASS : M+H=470

### Example 3

To a solution of N-[(2R,3R)-3-aminomethyl-4-(N-benzyloxyamino)-2-isobutylsuccinyl]-L-2-pyridylalanine methylamide (50 mg) in methanol (10 ml) was added 37% formaldehyde solution (87 mg). After being stirred for 30 minutes sodium cyanoborohydride (67 mg) was added and the pH was adjusted to 3 by the addition of 1N hydrochloric acid (HCl). The mixture was stirred at room temperature for 30 minutes. Methanol was evaporated and the residue was poured into chloroform and the solution was extracted with 1N-HCl. The aqueous layer was neutralized with sodium hydrogen carbonate and re-extracted with chloroform. The organic layer was dried over MgSO<sub>4</sub> and concentrated in vacuo. The residue was triturated with ethyl acetate to give N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-(methylaminomethyl)-succinyl]-L-2-pyridylalanine methylamide (412 mg).

$[\alpha]_D^{23} = -39.2^\circ$  (c 0.13, 1N-HCl aq.)

mp : 179-182°C

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=6Hz), 0.77 (3H, d, J=6Hz), 0.80 (1H, m), 1.19-1.40 (2H, m), 1.86 (0.5x1H, s, rotamer), 2.13 (0.5x1H, s, rotamer), 1.92-2.52 (4H, m), 2.57 (3H, d, J=5Hz), 2.93-3.13 (2H, m), 4.67-4.85 (3H, m), 7.17-8.40 (12H, m)

TLC : R<sub>f</sub> 0.20 (CHCl<sub>3</sub>:MeOH=5:1)

### Example 4-1)

To a solution of N-[(2R,3R)-N-3-aminomethyl-4-(N-benzyloxyamino-2-isobutylsuccinyl)-L-4-pyridylalanine methylamide (247 mg) and picolinic acid (62 mg) in DMF (5 ml) were added HOBT (75 mg) and WSCD (90 mg) at 0°C. The mixture was stirred at 0°C for 1.5 hours. DMF was evaporated and the residue was poured into water. The precipitate was collected

by filtration and washed with water and ethyl acetate to give N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide (136 mg).

5 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.84 (1H, m), 1.29 (1H, m), 1.37 (1H, m), 2.36 (1H, ddd, J=10, 9, 4Hz), 2.45-2.63 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.78-2.91 (2H, m), 2.97 (1H, dd, J=14, 6Hz), 3.18 (1H, m), 4.57 (1H, m), 4.57  
10 (1H, d, J=11Hz), 4.71 (1H, d, J=11Hz), 7.20-7.33 (7H, m), 7.60 (1H, m), 7.87 (1H, q, J=4.5Hz), 7.95-8.05 (2H, m), 8.25 (1H, dd, J=6, 6Hz), 8.37 (2H, d, J=7Hz), 8.45 (1H, d, J=8Hz), 8.62 (1H, br d, J=5Hz), 11.10 (1H, s)

15 HPLC : 10.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=575

20 The following compounds were obtained in substantially the same manner as that of Example 4-1).

#### Example 4-2)

25 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(6-methylpyridin-2-yl)carbonylaminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -23.5^\circ$  (c 0.21, 1N-HCl aq.)

mp : 248-254°C

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.84 (1H, m), 1.30 (1H, m), 1.39 (1H, m), 2.35 (1H, ddd, J=10, 9, 4Hz), 2.45-2.63 (1H, m), 2.48 (3H, s), 2.58 (3H, d, J=5Hz), 2.80-2.91 (1H, m), 2.85 (1H, dd, J=14, 11Hz), 2.97 (1H, dd, J=14, 5Hz), 3.13 (1H, m), 4.55 (1H, d, J=11Hz), 4.58 (1H, ddd, J=11, 8, 5Hz), 4.75 (1H, d, J=11Hz), 7.20-7.33  
35

(7H, m), 7.45 (1H, br d, J=7.5Hz), 7.78-7.92 (3H, m), 8.14 (1H, dd, J=6, 6Hz), 8.38 (2H, d, J=6Hz), 8.43 (1H, d, J=8Hz), 11.13 (1H, s)

HPLC : 6.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=589

Example 4-3)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -21.6^\circ$  (c 0.27; 1N-HCl aq.)

mp : 252-256°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.84 (1H, m), 1.30 (1H, m), 1.37 (1H, m), 2.36 (1H, ddd, J=9, 9, 4Hz), 2.47-2.61 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.78-2.91 (2H, m), 2.91 (1H, dd, J=14, 5Hz), 3.20 (1H, m), 4.57 (1H, m), 4.57 (1H, d, J=11Hz), 4.72 (1H, d, J=11Hz), 7.20-7.31 (7H, m), 7.60 (1H, m), 7.87 (1H, q, J=4.5Hz), 7.96-8.05 (2H, m), 8.26 (1H, dd, J=6, 6Hz), 8.37 (2H, d, J=7Hz), 8.45 (1H, d, J=8Hz), 8.63 (1H, br d, J=4Hz), 11.09 (1H, s)

HPLC : 10.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=575

Example 4-4)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(3-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -23.8^\circ$  (c 0.20, 1N-HCl aq.)

mp : 246-250°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77-0.90 (1H, m), 0.80 (3H, d, J=7Hz), 1.28 (1H, m), 1.40 (1H, m), 2.33 (1H, ddd, J=9, 9, 4Hz), 2.45-2.56 (1H, m), 2.59 (3H, d, J=4.5Hz), 2.74-3.03 (2H, m), 2.85 (1H, dd, J=14, 11Hz), 2.98 (1H, dd, J=14, 5Hz), 4.58 (1H, d, J=12Hz), 4.61 (1H, m), 4.74 (1H, d, J=12Hz), 7.21-7.32 (7H, m), 7.49 (1H, dd, J=7.5, 5Hz), 7.88 (1H, q, J=4.5Hz), 8.12 (1H, br d, J=7.5Hz), 8.33-8.45 (2H, m), 8.38 (2H, d, J=6Hz), 8.68 (1H, d, J=5Hz), 8.95 (1H, s), 11.04 (1H, s)

HPLC : 9.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=575

#### Example 4-5)

N-[(2R,3R)-4-(N-(Benzyloxyamino)-2-isobutyl-3-[(3-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -23.3^\circ$  (c 0.24, 1N-HCl aq.)

mp : 256-258°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.77-0.89 (1H, m), 0.80 (3H, d, J=7Hz), 1.28 (1H, m), 1.40 (1H, m), 2.33 (1H, ddd, J=9, 9, 4Hz), 2.44-2.55 (1H, m), 2.59 (3H, d, J=4.5Hz), 2.74-2.87 (1H, m), 2.85 (1H, dd, J=13, 10Hz), 2.90-3.03 (1H, m), 2.98 (1H, dd, J=13, 5Hz), 4.58 (1H, d, J=11Hz), 4.61 (1H, m), 4.73 (1H, d, J=11Hz), 7.21-7.31 (7H, m), 7.49 (1H, dd, J=7.5, 5Hz), 7.89 (1H, q, J=4.5Hz), 8.12 (1H, ddd, J=7.5, 1.5, 1.5Hz), 8.34-8.45 (2H, m), 8.37 (2H, d, J=6Hz), 8.69 (1H, dd, J=5, 1.5Hz), 8.95 (1H, d, J=1.5Hz), 11.04 (1H, s)

HPLC : 4.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=575

Example 4-6)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(4-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -26.3^\circ$  (c 0.24, 1N-HCl aq.)

mp : 255-259°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.75-0.90 (1H, m), 0.80 (3H, d, J=7Hz), 1.28 (1H, m), 1.40 (1H, m), 2.33 (1H, m), 2.58 (3H, d, J=4.5Hz), 2.68-3.03 (5H, m), 4.58 (1H, d, J=11Hz), 4.61 (1H, m), 4.72 (1H, d, J=11Hz), 7.20-7.32 (7H, m), 7.68 (2H, d, J=6Hz), 7.88 (1H, q, J=4.5Hz), 8.37 (2H, d, J=6Hz), 8.41 (1H, d, J=8Hz), 8.48 (1H, dd, J=5, 5Hz), 8.70 (2H, d, J=6Hz), 11.04 (1H, s)

HPLC : 8.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=575

Example 4-7)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(6-methylpyridin-3-yl)carbonylaminomethyl]succinyl]-L-2-pyridylalanine methylamide

$[\alpha]_D^{23} = -26.0^\circ$  (c 0.05, 1N-HCl aq.)

mp : 240-242°C (dec.)

HPLC : 3.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFA aq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=485

Example 4-8)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(2-quinolinecarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine



methylamide

HPLC : 17.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min., at R.T.)

Example 4-9)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[3-  
quinolinecarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine  
methylamide

10 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=6Hz), 0.81 (3H, d,  
J=6Hz), 0.84 (1H, m), 1.28 (1H, m), 1.43 (1H, m),  
2.32-2.57 (2H, m), 2.59 (3H, d, J=5Hz), 2.80-2.90  
(1H, m), 2.94-3.02 (1H, m), 3.03 (1H, dd, J=12,  
9Hz), 3.14 (1H, dd, J=12, 6Hz), 4.58 (1H, d,  
15 J=11.3Hz), 4.76 (1H, d, J=11.3Hz), 4.78 (1H, m),  
7.07 (1H, ddd, J=7.5, 6, 1.5Hz), 7.12-7.25 (5H, m),  
7.30 (1H, dd, J=7.5, 1.5Hz), 7.63 (1H, ddd, J=7.5,  
6, 1.5Hz), 7.70 (1H, dd, J=7.5, 1.5Hz), 7.74-7.80  
(1H, m), 7.86 (1H, ddd, J=7.5, 6, 1.5Hz), 8.07 (2H,  
20 ddd, J=7.5, 6, 1.5Hz), 8.39-8.44 (2H, m), 8.37-8.46  
(2H, m), 8.56-8.61 (1H, m), 8.77 (1H, d, J=1.5Hz),  
9.25 (1H, d, J=1.5Hz)

HPLC : 6.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
25 ml/min., at R.T.)

MASS : M+H=625

Example 4-10)

30 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(6-  
methylpyridin-2-yl)carbonylaminomethyl]succinyl]-L-2-  
pyridylalanine methylamide

HPLC : 7.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min., at R.T.)

35 MASS : M+H=589

Example 4-11)

N-[(2R,3R)-4-(N-Benzyloxyamino)-3-[(4-hydroxyquinolin-2-yl)carbonylaminomethyl]-2-isobutylsuccinyl]-L-2-pyridylalanine methylamide

5 HPLC : 5.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min. at R.T.)

MASS : M+H=641

10 Example 4-12)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(1-pyrrolidinylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -17.2^\circ$  (c 0.26, 1N-HCl aq.)

15 mp : 213-216°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.68 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.82 (1H, m), 1.19 (1H, m), 1.34 (1H, m), 1.66-1.82 (4H, m), 2.26 (1H, m), 2.44 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.70-3.03 (4H, m), 3.05-3.24 (4H, m), 4.53 (1H, m), 4.70 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.67 (1H, br), 7.23 (2H, d, J=6Hz), 7.35 (5H, s), 7.85 (1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.40 (2H, d, J=6Hz), 10.95 (1H, s)

20 HPLC : 4.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
25 MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=567

Example 4-13)

30 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(3-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methylamide

HPLC : 3.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
35 MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min. at R.T.)

Example 4-14)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methylamide

5 HPLC : 6.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min., at R.T.)

Example 5-1)

10 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[N-methyl-N-(2-quinolylcarbonyl)amino]methylsuccinyl]-L-2-pyridylalanine methylamide

HPLC : 3.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 40:60, 260 nm, flow rate 1.0  
15 ml/min., at R.T.)

MASS : M+H=639

Example 5-2)

20 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[N-methyl-N-[(6-methylpyridin-2-yl)carbonylamino]methylsuccinyl]-L-2-pyridylalanine methylamide

HPLC : 5.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min. at R.T.)

25 MASS : M+H=603

Example 5-3)

30 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[N-methyl-N-(3-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methylamide

NMR (CDCl<sub>3</sub>,  $\delta$ ) : 0.79 (3H, d, J=6Hz), 0.86 (3H, d,  
J=6Hz), 0.86-1.50 (3H, m), 0.95 (1H, m), 2.72 (3H,  
d, J=5Hz), 2.96 (3H, s), 3.04-3.14 (4H, m), 3.17-  
3.39 (2H, m), 4.71-4.97 (3H, m), 7.12-8.69 (13H, m)

35 HPLC : 12.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,

MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

Example 5-4)

5 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[N-methyl-  
N-(2-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine  
methanamide

HPLC : 6.3 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
10 ml/min., at R.T.)

MASS : M+H=589

Example 6-1)

15 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[3-  
(pyridin-3-yl)propionylaminomethyl]succinyl]-L-4-  
pyridylalanine methanamide

$[\alpha]_D^{25} = -47.9^\circ$  (c 0.25, 1N-HCl aq.)

mp : 249-253°C (dec.)

20 NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.73-0.89 (1H,  
m), 0.77 (3H, d, J=7Hz), 1.24 (1H, m), 1.37 (1H,  
m), 2.19 (1H, m), 2.24-2.35 (2H, m), 2.42 (1H, m),  
2.56 (3H, d, J=5Hz), 2.64 (1H, m), 2.71-2.89 (4H,  
m), 2.96 (1H, dd, J=14, 5Hz), 4.58 (1H, m), 4.70  
(1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 7.19-7.42  
25 (6H, m), 7.23 (2H, d, J=6Hz), 7.52-7.64 (2H, m),  
7.85 (1H, q, J=5Hz), 8.25-8.47 (3H, m), 8.37 (2H,  
d, J=6Hz), 11.02 (1H, s)

HPLC : 6.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
30 ml/min., at R.T.)

MASS : M+H=603

Example 6-2)

35 N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-[(3-  
pyridyl)acetamidomethyl]succinyl]-L-4-pyridylalanine

methylamide

$[\alpha]_D^{23} = -52.5^\circ$  (c 0.22, 1N-HCl aq.)

mp : 258-261°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.73-0.87  
5 (1H, m), 0.76 (3H, d, J=7Hz), 1.23 (1H, m),  
1.37 (1H, m), 2.20 (1H, m), 2.42 (1H, m),  
2.54 (3H, d, J=4.5Hz), 2.62-2.75 (2H, m),  
2.81 (1H, dd, J=14, 11Hz), 2.95 (1H, dd, J=14,  
5Hz), 3.35 (2H, d, J=6Hz), 4.56 (1H, m), 4.64 (1H,  
10 d, J=11Hz), 4.75 (1H, d, J=11Hz), 7.23 (2H, d,  
J=6Hz), 7.30 (1H, dd, J=7.5, 5Hz), 7.35 (5H, s),  
7.62 (1H, m), 7.80-7.95 (2H, m), 8.27-8.46 (5H, m),  
11.06 (1H, s)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
15 MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=589

#### Example 7

20 To a solution of N-[(2R,3R)-3-aminomethyl-4-(N-  
benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide (413 mg) and N,N-diisopropyl-N-ethylamine (142  
mg) in DMF (8 ml) was added N,N-dimethylcarbonyl chloride  
(105 mg) at 0°C. The mixture was stirred at room temperature  
25 overnight. The solution was evaporated. The precipitate was  
collected by filtration and was washed with water and ethyl  
acetate. That solid was further purified by silica gel  
column chromatography (eluent : methanol/ethyl acetate=1/10)  
to give N-[(2R,3R)-4-(N-benzyloxyamino)-3-(N',N'-  
30 dimethylureido)methyl-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide (276 mg).

$[\alpha]_D^{23} = 23.2^\circ$  (c 0.26, 1N-HCl aq.)

mp : 209-211°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.77 (3H, d, J=7Hz), 0.84 (3H, d,  
35 J=7Hz), 0.91 (1H, m), 1.18 (1H, m), 1.34 (1H, m),

2.27 (1H, m), 2.43 (1H, m), 2.55 (3H, d, J=4.5Hz),  
2.67-3.03 (3H, m), 2.71 (6H, s), 2.98 (1H, dd,  
J=14, 5Hz), 4.52 (1H, m), 4.70 (1H, d, J=11Hz),  
4.80 (1H, d, J=11Hz), 5.90 (1H, dd, J=5, 4Hz), 7.23  
5 (2H, d, J=6Hz), 7.36 (5H, s), 7.85 (1H, q,  
J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.40 (2H, d, J=6Hz),  
10.95 (1H, s)

HPLC : 5.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
10 ml/min., at R.T.)

MASS : M+H=541

#### Example 8-1)

To a solution of N-[(2R,3R)-3-aminomethyl-4-(N-  
15 benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide (380 mg) in DMF (3 ml) and pyridine (3 ml) were  
added acetic anhydride (103 mg) at room temperature. The  
mixture was stirred at room temperature for 2 hours. DMF was  
evaporated and the residue was poured into water. The  
20 precipitate was collected by filtration and washed with water  
and ethyl acetate to give N-[(2R,3R)-3-acetamidomethyl-4-(N-  
benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide (367 mg).

$[\alpha]_D^{25} = -37.7^\circ$  (c 0.28, 1N-HCl aq.)

25 mp : 253-256°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.74-0.87 (1H,  
m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.36 (1H,  
m), 1.70 (3H, s), 2.17 (1H, m), 2.41 (1H, m),  
2.53-2.69 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.76 (1H,  
30 m), 2.84 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14,  
5Hz), 4.56 (1H, ddd, J=11, 8, 5Hz), 4.72 (1H, d,  
J=11Hz), 4.79 (1H, d, J=11Hz), 7.24 (2H, d, J=6Hz),  
7.28-7.43 (5H, m), 7.53 (1H, dd, J=6, 6Hz), 7.86  
(1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.38 (2H, d,  
35 J=6Hz), 11.00 (1H, s)

HPLC : 5.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=512

5

#### Example 8-2)

N-[(2R,3R)-4-(N-Benzyloxyamino)-2-isobutyl-3-(propionylaminomethyl)succinyl]-L-4-pyridylalanine methylamide was obtained in substantially the same manner as that of Example 8-1).

10

$[\alpha]_D^{25} = -49.7^\circ$  (c 0.21, 1N-HCl aq.)

mp : 245-247°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.86 (1H, m), 0.77 (3H, d, J=7Hz), 0.93 (3H, t, J=7.5Hz), 1.23 (1H, m), 1.35 (1H, m), 1.97 (2H, q, J=7.5Hz), 2.17 (1H, m), 2.42 (1H, m), 2.55 (3H, d, J=5Hz), 2.60-2.90 (3H, m), 2.96 (1H, dd, J=13, 5Hz), 4.57 (1H, m), 4.70 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 7.24 (2H, d, J=6Hz), 7.28-7.52 (6H, m), 7.86 (1H, q, J=5Hz), 8.31 (1H, d, J=8Hz), 8.38 (2H, d, J=6Hz), 11.00 (1H, s)

15

20

HPLC : 6.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

25

MASS : M+H=526

#### Example 9

N-[(2R,3R)-4-(N-Benzyloxyamino)-3-(N,N-dimethylamino)-acetamidomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide was obtained in substantially the same manner as that of Example 4-1).

30

$[\alpha]_D^{23} = -56.3^\circ$  (c 0.23, 1N-HCl aq.)

mp : 243-248°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.74-0.87 (1H, m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.35 (1H,

35

m), 2.16 (2x3H, s), 2.20 (1H, m), 2.44 (1H, m),  
2.57 (3H, d, J=4.5Hz), 2.65 (1H, m), 2.75 (2H, s),  
2.77-2.91 (2H, m), 2.95 (1H, dd, J=14, 5Hz), 4.55  
(1H, m), 4.72 (1H, d, J=11Hz), 4.77 (1H, d,  
5 J=11Hz), 7.20-7.29 (3H, m), 7.36 (5H, s), 7.85 (1H,  
q, J=4.5Hz), 8.33-8.43 (3H, m), 11.07 (1H, s)

HPLC : 5.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

10 MASS : M+H=555

#### Example 10

N-[(2R,3R)-3-Benzamidomethyl-4-(N-benzyloxyamino)-2-  
isobutylsuccinyl]-L-4-pyridylalanine methylamide was obtained  
15 in substantially the same manner as that of Example 4-1).

$[\alpha]_D^{25} = -15.8^\circ$  (c 0.22, HCOOH)

mp : 243-247°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.75-0.91 (1H,  
m), 0.80 (3H, d, J=7Hz), 1.26 (1H, m), 1.39 (1H,  
20 m), 2.36 (1H, m), 2.45-2.63 (1H, m), 2.57 (3H, d,  
J=5Hz), 2.76-2.90 (2H, m), 2.91-3.05 (2H, m), 4.57  
(1H, d, J=11Hz), 4.60 (1H, m), 4.72 (1H, d,  
J=11Hz), 7.19-7.33 (7H, m), 7.38-7.54 (3H, m),  
7.74-7.84 (2H, m), 7.88 (1H, q, J=5Hz), 8.14 (1H,  
25 br), 8.31-8.47 (3H, m), 10.99 (1H, s)

HPLC : 6.8 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=575

#### Example 11

To a solution of N-[(2R,3R)-3-aminomethyl-4-(N-  
benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide (356 mg) in DMSO (6 ml) was added phenyl  
35 isocyanate (93 mg). The mixture was stirred at 50°C for 2



hours. The solvent was evaporated and the residue was poured into water. The precipitate was collected by filtration and washed with water and ethyl acetate to give N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-[(N'-phenylureido)methyl]-succinyl]-L-4-pyridylalanine methylamide (409 mg).

$[\alpha]_D^{25} = -36.5^\circ$  (c 0.19, HCOOH)

mp : 239-243°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.82 (1H, m), 1.24 (1H, m), 1.37 (1H, m), 2.25 (1H, m), 2.41 (1H, m), 2.57 (3H, d, J=5Hz), 2.70-2.92 (3H, m), 2.98 (1H, dd, J=14, 5Hz), 4.57 (1H, m), 4.74 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.91 (1H, br), 6.88 (1H, dd, J=7, 7Hz), 7.14-7.43 (11H, m), 7.85 (1H, q, J=5Hz), 8.31 (1H, d, J=8Hz), 8.35-8.47 (3H, m), 11.15 (1H, s)

HPLC : 7.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=589

#### Example 12-1)

To a solution of N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide (115 mg) in a mixture of cyclohexene (1 ml) and ethanol (20 ml) was added 10% palladium on carbon. The mixture was stirred under reflux for 2.5 hours. After the catalyst was filtered off, the filtrate was evaporated. The resulting residue was triturated with ethyl acetate to give N-[(2R,3R)-4-(N-hydroxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]-succinyl]-L-4-pyridylalanine methylamide (91 mg).

mp : 239-242°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.91 (1H, m), 1.30 (1H, m), 1.41 (1H, m), 2.38 (1H, ddd, J=9, 9, 4Hz), 2.47-2.61 (1H, m),

2.57 (3H, d, J=4.5Hz), 2.80-2.91 (1H, m), 2.85 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 3.24 (1H, m), 4.57 (1H, ddd, J=11, 8, 5Hz), 7.25 (2H, d, J=7Hz), 7.60 (1H, dd, J=6, 6Hz), 7.87 (1H, q, J=4.5Hz), 7.95-8.06 (2H, m), 8.17 (1H, dd, J=5.5, 5.5Hz), 8.37 (2H, d, J=7Hz), 8.43 (1H, d, J=8Hz), 8.63 (1H, d, J=6Hz), 8.85 (1H, s), 10.50 (1H, s)

HPLC : 8.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=485

The following compounds were obtained in substantially the same manner as that of Example 12-1).

#### Example 12-2)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(6-methylpyridin-3-yl)carbonylaminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -37.4^\circ$  (c 0.29, 1N-HCl aq.)

mp : 237-242°C

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.91 (1H, ddd, 13, 3, 3Hz), 1.30 (1H, m), 1.41 (1H, m), 2.38 (1H, ddd, J=9, 9, 4Hz), 2.53 (3H, s), 2.58 (3H, d, J=4.5Hz), 2.80-2.91 (1H, m), 2.85 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 3.24 (1H, m), 4.57 (1H, ddd, J=11, 8, 5Hz), 7.25 (2H, d, J=7Hz), 7.45 (1H, br-d, J=7.5Hz), 7.78-7.91 (3H, m), 8.10 (1H, dd, J=5.5, 5.5Hz), 8.37 (2H, d, J=7Hz), 8.41 (1H, d, J=8Hz), 8.86 (1H, s), 10.51 (1H, s)

HPLC : 4.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=499

Example 12-3)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

5  $[\alpha]_D^{25} = -30.1^\circ$  (c 0.31, 1N-HCl aq.)

mp : 240-242°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.91 (1H, m), 1.29 (1H, m), 1.41 (1H, m), 2.38 (1H, ddd, J=9, 9, 4Hz), 2.48-2.61 (1H, m), 10 2.58 (3H, d, J=4.5Hz), 2.80-2.91 (1H, m), 2.85 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 3.24 (1H, m), 4.56 (1H, ddd, J=11, 8, 5Hz), 7.25 (2H, d, J=7Hz), 7.60 (1H, m), 7.86 (1H, q, J=4.5Hz), 7.96-8.05 (2H, m), 8.16 (1H, dd, J=6, 6Hz), 8.37 (2H, d, 15 J=6Hz), 8.42 (1H, d, J=8Hz), 8.62 (1H, br d, J=5Hz), 8.85 (1H, s), 10.49 (1H, s)

HPLC : 9.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

20 MASS : M+H=485

Example 12-4)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(3-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine 25 methylamide

$[\alpha]_D^{25} = -27.7^\circ$  (c 0.20, 1N-HCl aq.)

mp : 229-235°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, m), 1.27 (1H, m), 1.43 (1H, m), 30 2.35 (1H, ddd, J=9, 9, 4Hz), 2.43-2.55 (1H, m), 2.59 (3H, d, J=4.5Hz), 2.75 (1H, m), 2.84 (1H, dd, J=14, 12Hz), 2.92-3.08 (1H, m), 2.98 (1H, dd, J=14, 5Hz), 4.60 (1H, ddd, J=12, 8, 5Hz), 7.26 (2H, d, J=7Hz), 7.49 (1H, dd, J=7.5, 5Hz), 7.88 (1H, q, 35 J=4.5Hz), 8.10 (1H, ddd, J=7.5, 1.5, 1.5Hz), 8.23

(1H, dd, J=6, 6Hz), 8.47 (2H, d, J=6Hz), 8.50 (1H, d, J=8Hz), 8.68 (1H, dd, J=5, 5Hz), 8.73 (1H, s), 8.92 (1H, d, J=1.5Hz), 10.35 (1H, s)

HPLC : 4.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min. at R.T.)

MASS : M+H=485

Example 12-5)

To a solution of N-[(2R,3R)-4-(N-benzyloxyamino)-2-isobutyl-3-[(4-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide (375 mg) in a mixture of cyclohexene (2 ml), formic acid (3.5 ml) and ethanol (20 ml) was added 5% palladium on barium sulfate. The mixture was stirred under reflux for 12 hours. After the catalyst was filtered off, the filtrate was evaporated. The resulting residue was triturated with ethyl acetate to give N-[(2R,3R)-4-(N-hydroxyamino)-2-isobutyl-3-(4-pyridylcarbonyl)-aminomethylsuccinyl]-L-4-pyridylalanine methylamide (16 mg).

$[\alpha]_D^{23} = -27.6^\circ$  (c 0.30, 1N-HCl aq.)

mp : 243-248°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, m), 1.28 (1H, m), 1.42 (1H, m), 2.35 (1H, ddd, J=9, 9, 3Hz), 2.45-2.55 (1H, m), 2.58 (3H, d, J=4.5Hz), 2.76 (1H, m), 2.84 (1H, dd, J=14, 11Hz), 2.92-3.08 (1H, m), 2.97 (1H, dd, J=14, 5Hz), 4.60 (1H, ddd, J=11, 8, 5Hz), 7.26 (2H, d, J=7Hz), 7.49 (1H, dd, J=7.5, 5Hz), 7.88 (1H, q, J=4.5Hz), 8.10 (1H, ddd, J=7.5, 1.5, 1.5Hz), 8.22 (1H, dd, J=5.5, 5.5Hz), 8.37 (2H, d, J=7Hz), 8.40 (1H, d, J=8Hz), 8.69 (1H, dd, J=5, 1.5Hz), 8.75 (1H, s), 8.92 (1H, d, J=1.5Hz), 10.36 (1H, s)

HPLC : 4.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=485

The following compounds were obtained in substantially the same manner as that of Example 12-5).

5

Example 12-6)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(4-pyridylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

10  $[\alpha]_D^{23} = -30.2^\circ$  (c 0.34, 1N-HCl aq.)

mp : 244-248°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.75 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.89 (1H, m), 1.28 (1H, m), 1.43 (1H, m), 2.35 (1H, m), 2.43-2.54 (1H, m), 2.59 (3H, d, J=5Hz), 2.72 (1H, m), 2.84 (1H, dd, J=14, 12Hz), 2.91-3.08 (2H, m), 4.60 (1H, m), 7.25 (2H, d, J=6Hz), 7.67 (2H, d, J=6Hz), 7.88 (1H, q, J=5Hz), 8.25-8.44 (4H, m), 8.65-8.78 (3H, m), 10.35 (1H, s)

20 HPLC : 4.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=485

25 Example 12-7)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[3-(pyridin-3-yl)propionylaminomethyl]succinyl]-L-4-pyridylalanine methylamide

30  $[\alpha]_D^{25} = -23.3^\circ$  (c 0.30, 1N-HCl aq.)

mp : 241-246°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.86 (1H, m), 1.23 (1H, m), 1.38 (1H, m), 2.21 (1H, m), 2.31 (2H, t, J=7Hz), 2.40 (1H, m), 2.55 (3H, d, J=5Hz), 2.61-2.89 (5H, m), 2.95 (1H, dd, J=13, 4Hz), 4.55 (1H, m), 7.23 (2H, d, J=6Hz),

35

7.30 (1H, dd, J=7.5, 5Hz), 7.46 (1H, dd, J=6, 6Hz),  
7.60 (1H, m), 7.85 (1H, q, J=5Hz), 8.30 (1H, d,  
J=8Hz), 8.34-8.44 (4H, m), 8.78 (1H, s), 10.35 (1H,  
s)

5 HPLC : 3.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=513

10 Example 12-8)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(3-  
pyridylacetamido)methyl]succinyl]-L-4-pyridylalanine  
methyliamide

$[\alpha]_D^{25} = -35.2^\circ$  (c 0.24, 1N-HCl aq.)

15 mp : 230-236°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.86 (1H, m), 1.23 (1H, m), 1.38 (1H, m),  
2.21 (1H, m), 2.41 (1H, m), 2.55 (3H, d, J=4Hz),  
2.61-2.88 (3H, m), 2.95 (1H, dd, J=13, 4Hz), 3.37  
20 (2H, s), 4.55 (1H, m), 7.22 (2H, d, J=6Hz), 7.31  
(1H, m), 7.64 (1H, m), 7.77 (1H, m), 7.84 (1H, q,  
J=4Hz), 8.29 (1H, d, J=8Hz), 8.34 (2H, d, J=6Hz),  
8.37-8.45 (2H, m), 8.67 (1H, s), 10.38 (1H, s)

HPLC : 3.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,

25 MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=499

Example 12-9)

30 N-[(2R,3R)-3-(N,N-Dimethylamino)acetamidomethyl-4-(N-  
hydroxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine  
methyliamide

$[\alpha]_D^{23} = -29.5^\circ$  (c 0.26, 1N-HCl aq.)

mp : 230-235°C (dec.)

35 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d,

J=7Hz), 0.87 (1H, m), 1.26 (1H, m), 1.38 (1H, m),  
2.11 (1H, m), 2.13 (2x3H, s), 2.33 (1H, m), 2.56  
(3H, d, J=4Hz), 2.63 (1H, m), 2.76-3.01 (5H, m),  
4.55 (1H, m), 7.25 (2H, d, J=6Hz), 7.25 (1H, m),  
5 7.86 (1H, q, J=4Hz), 8.35 (1H, d, J=8Hz), 8.39 (2H,  
d, J=6Hz), 8.80 (1H, s), 10.44 (1H, s)

HPLC : 3.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

10 MASS : M+H=465

Example 12-10)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[3-(6-  
methylpyridin-3-yl)carbonylaminomethyl]succinyl]-L-2-  
15 pyridylalanine methylamide

$[\alpha]_D^{23} = -37.9^\circ$  (c 0.14, 1N-HCl aq.)

mp : 204-207°C

20 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=6Hz), 0.78 (3H, d,  
J=6Hz), 0.88 (1H, ddd, J=12, 9, 1.5Hz), 1.24 (1H,  
m), 1.43 (1H, ddd, J=12, 9, 1.5Hz), 2.32-2.49 (2H,  
m), 2.50 (3H, s), 2.57 (3H, d, J=5Hz), 2.70-2.80  
(1H, m), 2.93-3.02 (1H, m), 3.00 (1H, dd, J=12,  
9Hz), 3.11 (1H, dd, J=12, 6Hz), 4.76 (1H dd, J=9,  
6Hz), 7.06 (1H, ddd, J=7.5, 6, 1.5Hz), 7.26 (1H, d,  
25 J=7.5Hz), 7.32 (1H, d, J=7.5Hz), 7.60 (1H, ddd,  
J=7.5, 6, 1.5Hz), 7.73-7.80 (1H, m), 8.00 (1H, dd,  
J=7.5, 1.5Hz), 8.18 (1H, br s), 8.37-8.44 (2H, m),  
8.82 (1H, d, J=1.5Hz)

30 HPLC : 8.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=499

Example 12-11)

35 N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(2-  
quinolinecarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine

## methyliamide

 $[\alpha]_D^{23} = -60.0^\circ$  (c 0.10, 1N-HCl aq.)

mp : 232-236°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=6Hz), 0.80 (3H, d, J=6Hz), 0.86 (1H, m), 1.28 (1H, m), 1.46 (1H, m), 2.42 (2H, m), 2.61 (3H, d, J=5Hz), 2.85-3.30 (4H, m), 4.80 (1H, m), 7.50-8.74 (13H, m)

HPLC : 3.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=535

Example 12-12)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(2-quinolinecarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methyliamide

 $[\alpha]_D^{25} = -35.6^\circ$  (c 0.09, 1N-HCl aq.)

mp : 244-246°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=6Hz), 0.80 (3H, d, J=6Hz), 0.91 (1H, m), 1.27 (1H, m), 1.45 (1H, m), 2.36-2.56 (2H, m), 2.59 (3H, d, J=5Hz), 2.76-3.06 (2H, m), 3.04 (1H, dd, J=12, 9Hz), 3.14 (1H, dd, J=12, 6Hz), 4.79 (1H, m), 7.07 (1H, ddd, J=7.5, 6, 1.5Hz), 7.29 (1H, dd, J=7.5, 1.5Hz), 7.62 (1H, ddd, J=7.5, 6, 1.5Hz), 7.70 (1H, dd, J=7.5, 1.5Hz), 7.74-7.80 (1H, m), 7.86 (1H, ddd, J=7.5, 6, 1.5Hz), 8.05-8.10 (2H, m), 8.36-8.46 (2H, m), 8.72-8.80 (2H, m), 9.23 (1H, s)

HPLC : 3.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=535

Example 12-13)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[N-methyl-N-



(2-quinolylcarbonyl)amino]methylsuccinyl]-L-2-pyridylalanine  
methyleamide

$[\alpha]_D^{23} = -37.5^\circ$  (c 0.12, 1N-HCl aq.)

mp : 203-205°C

5 NMR (CD<sub>3</sub>OD,  $\delta$ ) : 0.69-0.94 (6H, m), 1.03-1.48 (3H, m),  
2.25-2.61 (2H, m), 2.65 (0.5x3H, s, rotamer), 2.75  
(0.5x3H, s, rotamer), 2.83 (0.5x3H, s, rotamer),  
2.95 (0.5x3H, s, rotamer), 2.97-3.65 (4H, m), 4.67-  
4.96 (1H, m), 7.27-8.66 (10H, m)

10 HPLC : 7.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=485

15 Example 12-14)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(6-  
methylpyridin-2-yl)carbonylamino]methyl]succinyl]-L-2-  
pyridylalanine methyleamide

$[\alpha]_D^{23} = -42.9^\circ$  (c 0.14, 1N-HCl aq.)

20 mp : 248-252°C

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.74 (3H, d, J=6Hz), 0.78 (3H, d,  
J=6Hz), 0.90 (1H, ddd, J=12, 9, 1.5Hz), 1.28 (1H,  
m), 1.43 (1H, ddd, J=12, 9, 1.5Hz), 2.31-2.52 (2H,  
m), 2.54 (3H, s), 2.57 (3H, d, J=5Hz), 2.85 (1H,  
25 m), 3.03 (1H, dd, J=12, 9Hz), 3.13 (1H, dd, J=12,  
6Hz), 3.21 (1H, m), 4.73 (1H, dd, J=9, 6Hz), 7.05  
(1H, ddd, J=7.5, 6, 1.5Hz), 7.26 (1H, dd, J=7.5,  
1.5Hz), 7.45 (1H, dd, J=7.5, 1.5Hz), 7.57-7.89 (4H,  
m), 8.11 (1H, m), 8.35-8.43 (2H, m), 8.86 (1H, s)

30 HPLC : 22.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=499

35 Example 12-15)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[N-methyl-N-[(6-methylpyridin-2-yl)carbonyl]aminomethyl]succinyl]-L-2-pyridylalanine methylamide

$$[\alpha]_D^{23} = -40.0^\circ \text{ (c 0.14, 1N-HCl aq.)}$$

5 mp : 196-198°C

NMR (CD<sub>3</sub>OD,  $\delta$ ) : 0.74-0.90 (6H, m), 1.06 (1H, m), 1.35 (1H, m), 1.48 (1H, m), 2.35-2.57 (2H, m), 2.59 (0.5x3H, d, J=5Hz, rotamer), 2.68 (3H, s), 2.73 (0.5x3H, d, J=5Hz, rotamer), 2.89 (3H, s), 3.00-10 3.40 (4H, m), 4.67-4.95 (1H, m), 7.18-8.54 (7H, m)

HPLC : 14.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=513

15

Example 12-16)

N-[(2R,3R)-4-(N-Hydroxyamino)-3-[(4-hydroxyquinolin-2-yl)carbonylaminomethyl]-2-isobutylsuccinyl]-L-2-pyridylalanine methylamide

20 mp : 209-211°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.68-1.02 (7H, m), 1.30 (1H, m), 1.45 (1H, m), 2.27-2.84 (5H, m), 2.95-3.30 (4H, m), 4.77 (1H, m), 6.23 (1H, m), 7.07 (1H, m), 7.20-7.35 (2H, m), 7.50-7.67 (2H, m), 7.70-7.90 (2H, m), 8.07 25 (1H, m), 8.32-8.50 (3H, m), 8.82 (1H, br)

HPLC : 4.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=551

30

Example 12-17)

N-[(2R,3R)-3-(N',N'-Dimethylureido)methyl-4-(N-hydroxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

35  $[\alpha]_D^{23} = -26.3^\circ \text{ (c 0.26, 1N-HCl aq.)}$

mp : 200-204°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.87 (1H, m), 1.20 (1H, m), 1.37 (1H, m), 2.30 (1H, m), 2.44 (1H, m), 2.57 (3H, d, J=5Hz), 2.68-3.04 (4H, m), 2.73 (2x3H, s), 4.51 (1H, m), 5.67 (1H, dd, J=5, 5Hz), 7.24 (2H, d, J=6Hz), 7.86 (1H, q, J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.40 (2H, d, J=6Hz), 8.77 (1H, s), 10.29 (1H, s)

HPLC : 5.3 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=451

Example 12-18)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(1-pyrrolidinylcarbonyl)aminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -21.4^\circ$  (c 0.31, 1N-HCl aq.)

mp : 216-219°C

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.76 (3H, d, J=7Hz), 0.88 (1H, m), 1.19 (1H, m), 1.37 (1H, m), 1.71-1.85 (4H, m), 2.28 (1H, m), 2.45 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.76 (1H, m), 2.87 (1H, dd, J=14, 11Hz), 2.92-3.05 (2H, m), 3.08-3.26 (4H, m), 4.52 (1H, m), 5.42 (1H, dd, J=6, 5Hz), 7.24 (2H, d, J=7Hz), 7.87 (1H, q, J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.41 (2H, d, J=7Hz), 8.77 (1H, s), 10.30 (1H, s)

HPLC : 3.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=477

Example 12-19)

N-[(2R,3R)-3-Benzamidomethyl-4-(N-hydroxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -30.1^\circ$  (c 0.23, 1N-HCl aq.)

mp : 232-242°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, m), 1.27 (1H, m), 1.43 (1H, m), 2.40 (1H, m), 2.45-2.63 (1H, m), 2.58 (3H, d, J=4Hz), 2.75-3.14 (4H, m), 4.58 (1H, m), 7.21-7.30 (2H, m), 7.38-7.57 (3H, m), 7.77 (2H, d, J=7Hz), 7.88 (1H, q, J=4Hz), 7.95 (1H, br), 8.32-8.45 (3H, m), 8.74 (1H, s), 10.35 (1H, s)

HPLC : 5.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=484

15 Example 12-20)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(3-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methanamide

$[\alpha]_D^{25} = -35.2^\circ$  (c 0.17, 1N-HCl aq.)

mp : 220-223°C

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=6Hz), 0.79 (3H, d, J=6Hz), 0.89 (1H, ddd, J=12, 9, 1.5Hz), 1.25 (1H, m), 1.43 (1H, ddd, J=12, 9, 1.5Hz), 2.31-2.50 (2H, m), 2.57 (3H, d, J=5Hz), 2.72-2.82 (1H, m), 2.93-3.02 (1H, m), 3.00 (1H, dd, J=12, 9Hz), 3.11 (1H, dd, J=12, 6Hz), 4.75 (1H, dd, J=9, 6Hz), 7.07 (1H, ddd, J=7.5, 6, 1.5Hz), 7.18 (1H, dd, J=7.5, 1.5Hz), 7.49 (1H, dd, J=7.5, 6Hz), 7.61 (1H, ddd, J=7.5, 6, 1.5Hz), 7.76-7.83 (1H, m), 8.12 (1H, dd, J=7.5, 1.5Hz), 8.33 (1H, br s), 8.37-8.46 (2H, m), 8.68 (1H, d, J=6Hz), 8.93 (1H, s)

HPLC : 6.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=485

Example 12-21)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(2-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methylamide

5  $[\alpha]_D^{23} = -42.3^\circ$  (c 0.04, 1N-HCl aq.)

mp : 265-268°C

NMR (0.5N-DCI,  $\delta$ ) : 0.52-0.60 (6H, m), 0.83 (1H, m),  
0.95 (1H, m), 1.26 (1H, m), 2.33-2.40 (2H, m), 2.46  
(3H, s), 2.65 (1H, m), 3.13 (1H, m), 3.23-3.43 (2H,  
10 m), 7.63-8.73 (8H, m)

HPLC : 3.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

15 MASS : M+H=485

Example 12-22)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[N-methyl-N-(3-pyridylcarbonyl)aminomethyl]succinyl]-L-2-pyridylalanine methylamide

20  $[\alpha]_D^{23} = -46.0^\circ$  (c 0.05, 1N-HCl aq.)

mp : 125-128°C

NMR (CD<sub>3</sub>OD,  $\delta$ ) : 0.78-0.95 (6H, m), 1.08 (1H, m), 1.38  
(1H, m), 1.58 (1H, m), 2.46-2.65 (2H, m), 2.72  
(0.3x3H, br s, minor rotamer), 2.76 (0.7x3H, br s,  
25 major rotamer), 2.83 (0.7x3H, br s, major rotamer),  
2.93 (0.3x3H, br s, minor rotamer), 3.04-3.33 (4H,  
m), 3.17-3.39 (2H, m), 4.87 (1H, m), 7.25-8.70 (8H,  
m)

HPLC : 6.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
30 MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=499

Example 12-23)

35 N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[N-methyl-N-

(2-pyridylcarbonyl)amino]methylsuccinyl]-L-2-pyridylalanine  
methanamide

$[\alpha]_D^{23} = -35.8^\circ$  (c 0.12, 1N-HCl aq.)

mp : 208-211°C

5 NMR (CD<sub>3</sub>OD,  $\delta$ ) : 0.76-0.91 (6H, m), 1.05 (1H, m), 1.36  
(1H, m), 1.54 (1H, m), 2.36 (1H, m), 2.56 (1H, m),  
2.68 (0.5x3H, s, rotamer), 2.73 (0.5x3H, s,  
rotamer), 2.76 (0.5x3H, s, rotamer), 2.90 (0.5x3H,  
s, rotamer), 3.00-3.42 (4H, m), 4.67-4.96 (1H, m),  
10 7.24-8.64 (8H, m)

HPLC : 10.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=499

15

Example 12-24)

N-[(2R,3R)-3-Acetamidomethyl-4-(N-hydroxyamino)-2-  
isobutylsuccinyl]-L-4-pyridylalanine methanamide

$[\alpha]_D^{25} = -30.5^\circ$  (c 0.30, 1N-HCl aq.)

20 mp : 246-250°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.85 (1H, m), 1.23 (1H, m), 1.38 (1H, m),  
1.71 (3H, s), 2.18 (1H, m), 2.41 (1H, m), 2.56 (3H,  
d, J=5Hz), 2.65-2.75 (2H, m), 2.83 (1H, dd, J=14,  
25 11Hz), 2.95 (1H, dd, J=14, 6Hz), 4.55 (1H, ddd,  
J=11, 8, 6Hz), 7.23 (2H, d, J=6Hz), 7.37 (1H, dd,  
J=6, 6Hz), 7.85 (1H, q, J=5Hz), 8.30 (1H, d,  
J=8Hz), 8.38 (2H, d, J=6Hz), 8.73 (1H, s), 10.33  
(1H, s)

30 HPLC : 4.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=422

35

Example 12-25)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-(propionylaminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -32.6^\circ$  (c 0.30, 1N-HCl aq.)

mp : 238-241°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.85 (1H, m), 0.96 (3H, t, J=7Hz), 1.23 (1H, m), 1.38 (1H, ddd, J=11, 11, 3Hz), 1.97 (2H, q, J=7Hz), 2.20 (1H, m), 2.41 (1H, m), 2.56 (3H, d, J=5Hz), 2.62-2.90 (3H, m), 2.96 (1H, dd, J=14, 5Hz), 4.55 (1H, m), 7.25 (2H, d, J=6Hz), 7.28 (1H, m), 7.86 (1H, q, J=5Hz), 8.30 (1H, d, J=8Hz), 8.37 (2H, d, J=6Hz), 8.72 (1H, s), 10.31 (1H, s)

HPLC : 4.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 1:10, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=436

Example 12-26)

N-[(2R,3R)-4-(N-Hydroxyamino)-2-isobutyl-3-[(N'-phenylureido)methyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -36.7^\circ$  (c 0.28, 1N-HCl aq.)

mp : 250-254°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.90 (1H, m), 1.25 (1H, m), 1.42 (1H, m), 2.25 (1H, m), 2.40 (1H, m), 2.57 (3H, d, J=5Hz), 2.77-2.92 (3H, m), 2.98 (1H, dd, J=14, 6Hz), 4.57 (1H, m), 5.81 (1H, dd, J=6, 4Hz), 6.87 (1H, dd, J=7, 7Hz), 7.15-7.28 (4H, m), 7.36 (2H, d, J=7.5Hz), 7.85 (1H, q, J=5Hz), 8.30 (1H, d, J=8Hz), 8.40 (2H, d, J=6Hz), 8.46 (1H, s), 8.85 (1H, s), 10.54 (1H, s)

HPLC : 3.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=499

### Example 13

N-[(2R,3R)-3-Aminomethyl-4-(N-benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide (1.73 g) was dissolved in water (15 ml) and the pH was adjusted to 8-9 by the addition of sodium hydrogen carbonate. The precipitate was collected by filtration to give N-[(2R,3R)-[3-aminomethyl-4-(N-benzyloxyamino)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide (1.02 g).

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.88 (1H, m), 0.77 (3H, d, J=7Hz), 1.15-1.40 (2H, m), 1.85-2.00 (2H, m), 2.23 (1H, m), 2.41 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.79 (1H, dd, J=14, 12Hz), 2.94 (1H, dd, J=14, 4Hz), 4.55 (1H, ddd, J=12, 8, 4Hz), 4.76 (2H, s), 7.25 (2H, d, J=6Hz), 7.28-7.44 (5H, m), 7.85 (1H, q, J=4.5Hz), 8.29 (1H, d, J=8Hz), 8.44 (2H, d, J=6Hz)

MASS : M+H=470

### Example 14

N-[(2R,3R)-4-Benzyloxyamino-2-isobutyl-3-phthalimidomethylsuccinyl]-L-3-pyridylalanine methyl ester was obtained in substantially the same manner as that of Example 1-1).

$[\alpha]_D^{25} = -6.3^\circ$  (c 0.20, AcOH)

mp : 214-219°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70-0.85 (1H, m), 0.75 (3H, d, J=6.5Hz), 0.80 (3H, d, J=6.5Hz), 1.30-1.46 (2H, m), 2.40 (1H, ddd, J=11, 10, 3Hz), 2.46-2.61 (1H, m), 2.90 (1H, dd, J=14, 11Hz), 3.17 (1H, dd, J=14, 5Hz), 3.50 (1H, dd, J=13, 11Hz), 3.62 (3H, s), 4.25 (1H, d, J=11Hz), 4.54 (1H, d, J=11Hz), 4.67 (1H, ddd, J=11, 8, 5Hz), 7.05 (2x1H, d, J=7.5Hz), 7.12-7.28 (4H, m), 7.70 (1H, br d, J=7.5Hz), 7.85 (4H,



m), 8.13 (1H, d, J=5Hz), 8.46 (1H, br), 8.65 (1H, d, J=7.5Hz), 11.06 (1H, s)

HPLC : 5.5 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=601

#### Example 15

N-[(2R,3R)-3-Aminomethyl-4-benzyloxyamino-2-isobutylsuccinyl]-L-3-pyridylalanine methylamide was obtained in substantially the same manner as that of Example 2-1).

$[\alpha]_D^{23} = -35.5^\circ$  (c 0.31, 1N-HCl aq.)

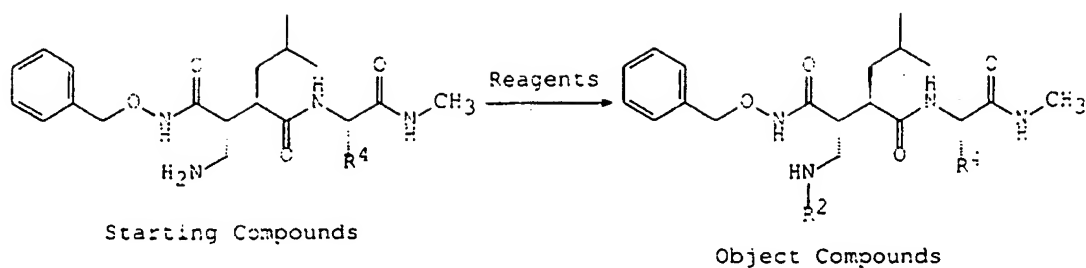
mp : 198-201°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.88 (1H, m), 0.78 (3H, d, J=7Hz), 1.17-1.39 (2H, m), 1.78-1.97 (2H, m), 2.21 (1H, dd, J=13, 3Hz), 2.40 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.79 (1H, dd, J=14, 11Hz), 2.94 (1H, dd, J=14, 4Hz), 4.36 (2H, br), 4.51 (1H, ddd, J=11, 8, 4Hz), 4.75 (1H, d, J=11Hz), 4.79 (1H, d, J=11Hz), 7.25-7.43 (5H, m), 7.29 (1H, dd, J=7.5, 5Hz), 7.65 (1H, br d, J=7.5Hz), 7.88 (1H, q, J=4.5Hz), 8.30 (1H, d, J=8Hz), 8.40 (1H, d, J=5Hz), 8.46 (1H, d, J=1.5Hz)

HPLC : 5.5 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 20:80:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=470

The Object Compounds listed in the following Table 1 were prepared, in substantially the same manner as that of Example 4-1), by reacting the Starting Compounds with the Reagent as shown below.

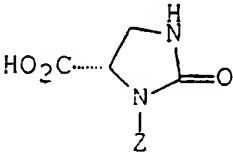
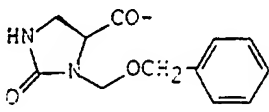

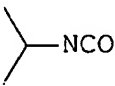
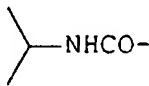
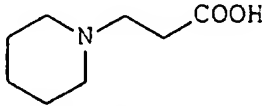
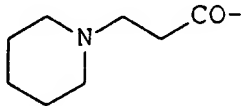
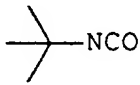
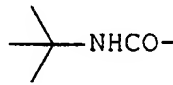


The abbreviations used in Table 1 are as follows.

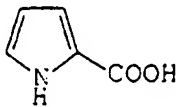
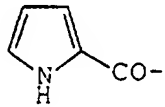
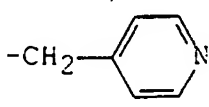
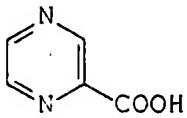
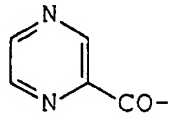
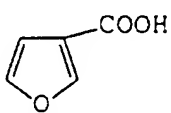
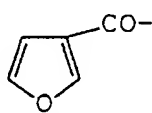
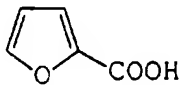
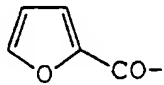
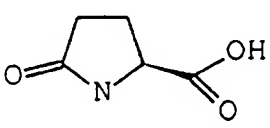
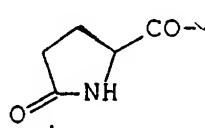
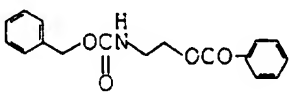
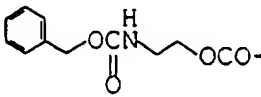
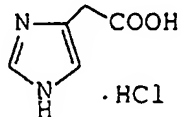
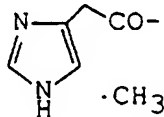
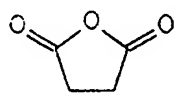
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 Et : ethyl  
 Ac : acetyl  
 Z : benzyloxycarbonyl  
 Boc : t-butoxycarbonyl  
 gly : glycine residue  
 Ser : Serine residue

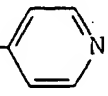
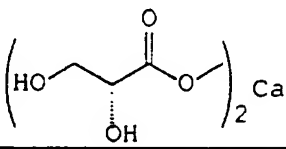
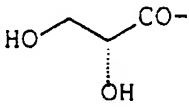


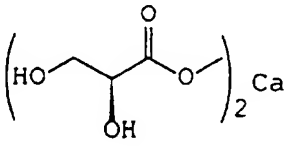
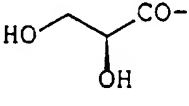

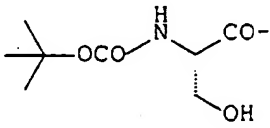
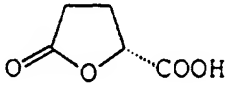
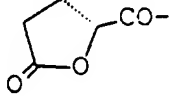
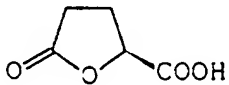
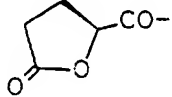
Table 1


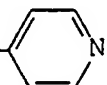
Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-1)	(Boc) <sub>2</sub> O		
-2)			"
-3)			"
-4)	EtOCOC1	EtOCO-	"

Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-5)			-CH <sub>2</sub> - 
-6)	EtO <sub>2</sub> CCH <sub>2</sub> COCl	EtOCOCH <sub>2</sub> CO-	"
-7)			"
-8)	EtNCO	EtNHCO-	"
-9)			"
-10)			"
-11)	AcOCH <sub>2</sub> COOH	AcOCH <sub>2</sub> CO-	"
-12)	MeOCOC1	MeOCO-	"
-13)	MeOCH <sub>2</sub> COC1	MeOCH <sub>2</sub> CO-	"
-14)	MeSO <sub>2</sub> Cl	MeSO <sub>2</sub> -	"

Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-15)			
-16)			"
-17)			"
-18)			"
-19)			"
-20)			"
-21)			"
-22)			"
-23)			"
-24)			"

Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-25)			
-26)			"
-27)	EtSO <sub>2</sub> Cl	EtSO <sub>2</sub> -	"
-28)			"
-29)			"
-30)	(CF <sub>3</sub> CO) <sub>2</sub> O	CF <sub>3</sub> CO-	"
-31)			"
-32)			"
-33)	 ·HCl	 ·CH <sub>3</sub> CO <sub>2</sub> H	"
-34)		HOCO-CH <sub>2</sub> -CH <sub>2</sub> -CO-	"

Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-35)	AcNH-CH <sub>2</sub> -COOH	AcNHCH <sub>2</sub> CO-	-CH <sub>2</sub> - 
-36)			"
-37)	MeOCOCH <sub>2</sub> NHCOO- 	MeOCOCH <sub>2</sub> NHCO-	"
-38)	MeNHCOO- 	MeNHCO-	"
-39)			"
-40)	MeSO <sub>2</sub> CH <sub>2</sub> COOH	MeSO <sub>2</sub> CH <sub>2</sub> CO-	"
-41)	AcO-CH <sub>2</sub> -CH <sub>2</sub> -OCO- 	AcO-CH <sub>2</sub> -CH <sub>2</sub> -OCO-	"
-42)	Boc-Ser		"
-43)			"
-44)			"

Example No.	Reagents	Object Compounds	
		R <sup>2</sup>	R <sup>4</sup>
16-45)	Boc-Gly-OH	 -OCONHCH <sub>2</sub> CO-	-CH <sub>2</sub> - 
-46)	H <sub>2</sub> NCOCOOH	H <sub>2</sub> NCOCO-	"
-47)	MeSO <sub>2</sub> Cl	MeSO <sub>2</sub> -	"
-48)	AcOCH <sub>2</sub> COOH	AcOCH <sub>2</sub> CO-	"
-49)	EtOCOC1	EtOCO-	"

The physico-chemical properties of the Object Compounds of Table 1 were described hereinafter.

Example 16-1)

$[\alpha]_D^{24} = -14.6^\circ$  (c 0.21, 1H-HCl aq.)

mp : 229-232°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.73-0.87 (1H, m), 0.79 (3H, d, J=7Hz), 1.18-1.42 (2H, m), 1.35 (3x3H, s), 2.13 (1H, m), 2.45 (1H, m), 2.47-2.60 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.65 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.94 (1H, dd, J=14, 5Hz), 4.55 (1H, ddd, J=11, 8, 5Hz), 4.71 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 6.32 (1H, dd, J=5, 5Hz), 7.25 (2x1H, d, J=7Hz), 7.30-7.43 (5H, m), 7.85 (1H, q, J=4.5Hz), 8.36 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 10.95 (1H, s)

HPLC : 7.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 30:70:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=570

5

Example 16-2)

$[\alpha]_D^{25} = -53.9^\circ$  (c 0.20, 1N-HCl aq.)

mp : 263-267°C (dec.)

10 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.73-0.87 (1H,  
m), 0.78 (3H, d, J=7Hz), 0.94 (3H, d, J=7Hz), 0.95  
(3H, d, J=7Hz), 1.23 (1H, m), 1.37 (1H, m), 2.11-  
2.33 (2H, m), 2.42 (1H, m), 2.53-2.78 (2H, m), 2.57  
(3H, d, J=5Hz), 2.83 (1H, dd, J=13, 11Hz), 2.97  
(1H, dd, J=13, 5Hz), 4.57 (1H, ddd, J=11, 8, 5Hz),  
15 4.70 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 7.25  
(2x1H, d, J=6Hz), 7.30-7.45 (6H, m), 7.87 (1H, d,  
J=5Hz), 8.33 (1H, d, J=8Hz), 8.38 (2x1H, d, J=6Hz),  
11.0 (1H, s)

20 HPLC : 8.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=540

Example 16-3)

25  $[\alpha]_D^{25} = -55.2^\circ$  (c 0.20, 1N-HCl aq.)

mp : 212-215°C

30 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.81 (1H, m), 1.02 (9H, s), 1.20 (1H, m),  
1.36 (1H, m), 2.25 (1H, m), 2.43 (1H, m), 2.57 (3H,  
d, J=5Hz), 2.65 (1H, m), 2.75-2.90 (2H, m), 2.97  
(1H, dd, J=14, 5Hz), 4.55 (1H, m), 4.69 (1H, d,  
J=11Hz), 4.79 (1H, d, J=11Hz), 7.09 (1H, m), 7.24  
(2x1H, d, J=6Hz), 7.28-7.41 (5H, m), 7.87 (1H, d,  
J=5Hz), 8.33 (1H, d, J=8Hz), 8.37 (2x1H, d, J=6Hz),  
35 8.40 (1H, d, J=8Hz), 11.00 (1H, s)



HPLC : 5.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=540

5

Example 16-4)

$[\alpha]_D^{25} = -10.9^\circ$  (c 0.22, 1N-HCl aq.)

mp : 223-241°C (dec.)

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.73-0.87 (1H,  
m), 0.78 (3H, d, J=7Hz), 1.13 (3H, t, J=7Hz), 1.19-  
1.42 (2H, m), 2.14 (1H, ddd, J=9, 9, 4Hz), 2.43  
(1H, m), 2.45-2.60 (1H, m), 2.56 (3H, d, J=4.5Hz),  
2.70 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.94 (1H,  
15 dd, J=14, 5Hz), 3.92 (2H, q, J=7Hz), 4.55 (1H, ddd,  
J=11, 8, 5Hz), 4.70 (1H, d, J=11Hz), 4.76 (1H, d,  
J=11Hz), 6.67 (1H, dd, J=5, 5Hz), 7.25 (2x1H, d,  
J=7Hz), 7.30-7.42 (5H, m), 7.85 (1H, q, J=4.5Hz),  
8.33 (1H, d, J=8Hz), 8.39 (2x1H, d, J=7Hz), 10.96  
(1H, s)

20 HPLC : 7.8 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=542

25 Example 16-5)

$[\alpha]_D^{24} = -50.7^\circ$  (c 0.12, 1N-HCl aq.)

mp : 216-220°C (dec.)

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.81 (1H, m), 1.24 (1H, m), 1.37 (1H, m),  
2.21 (1H, m), 2.39-2.60 (2H, m), 2.55 (3H, d,  
J=4.5Hz), 2.83 (1H, dd, J=14, 10Hz), 2.97 (1H, dd,  
J=14, 5Hz), 3.05 (1H, m), 3.20 (1H, dd, J=10, 4Hz),  
3.47 (1H, dd, J=10, 10Hz), 4.53-4.67 (2H, m), 4.71  
(1H, d, J=11Hz), 4.79 (1H, d, J=11Hz), 5.16 (2H,  
35 s), 7.22 (2x1H, d, J=6Hz), 7.25-7.47 (11H, m), 7.90

(1H, q, J=4.5Hz), 8.03 (1H, dd, J=6, 5Hz), 8.34  
(1H, d, J=8Hz), 8.37 (2x1H, d, J=6Hz), 11.17 (1H,  
s)

HPLC : 7.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 30:70:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=715

Example 16-6)

10  $[\alpha]_D^{25} = -40.7^\circ$  (c 0.20, 1N-HCl aq.)

mp : 228-231°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.17 (3H, t, J=7Hz), 1.24  
(1H, m), 1.37 (1H, m), 2.20 (1H, ddd, J=9, 9, 4Hz),  
15 2.42 (1H, m), 2.56 (3H, d, J=5Hz), 2.71 (1H, m),  
2.77-2.90 (1H, m), 2.83 (1H, dd, J=14, 11Hz), 2.95  
(1H, dd, J=14, 6Hz), 3.10 (1H, d, J=14Hz), 3.16  
(1H, d, J=14Hz), 4.05 (2H, q, J=7Hz), 4.57 (1H,  
ddd, J=11, 8, 5Hz), 4.72 (1H, d, J=11Hz), 4.80 (1H,  
20 d, J=11Hz), 7.23 (2x1H, d, J=7Hz), 7.30-7.42 (5H,  
m), 7.80-7.90 (2H, m), 8.32 (1H, d, J=8Hz), 8.39  
(2x1H, d, J=6Hz), 11.06 (1H, s)

HPLC : 4.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFA aq. = 30:70, 260 nm, flow rate 1.0  
25 ml/min., at R.T.)

MASS : M+H=584

Example 16-7)

30  $[\alpha]_D^{25} = -22.4^\circ$  (c 0.21, 1N-HCl aq.)

mp : 247-250°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.75 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.22 (1H, m), 1.36 (1H, m),  
2.20 (1H, ddd, J=9, 9, 4Hz), 2.37 (1H, m), 2.55  
(3H, d, J=4.5Hz), 2.69-2.91 (2H, m), 2.96 (1H, dd,  
35 J=14, 6Hz), 3.62 (1H, dq, J=7.5, 7, 7Hz), 4.54

(1H, m), 4.74 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.46 (1H, dd, J=6, 6Hz), 5.66 (1H, d, J=7.5Hz), 7.24 (2H, d, J=6Hz), 7.30-7.43 (5H, m), 7.84 (1H, q, J=4.5Hz), 8.27 (1H, d, J=8Hz), 8.41 (2H, d, J=6Hz), 11.10 (1H, s)

HPLC : 9.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS ...: M+H=555

Example 16-8)

$[\alpha]_D^{23} = -20.2^\circ$  (c 0.23, 1N-HCl aq.)

mp : 236-238°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.68 (3H, d, J=7Hz), 0.74 (3H, d, J=7Hz), 0.80 (1H, m), 0.95 (3H, t, J=7.5Hz), 1.19 (1H, m), 1.35 (1H, ddd, J=12, 11, 3Hz), 2.20 (1H, ddd, J=11, 10, 3Hz), 2.37 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.67-2.90 (3H, m), 2.91-3.02 (3H, m), 4.53 (1H, m), 4.73 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.53 (1H, dd, J=6, 5Hz), 5.74 (1H, t, J=6Hz), 7.23 (2x1H, d, J=6Hz), 7.29-7.42 (5H, m), 7.83 (1H, q, J=4.5Hz), 8.25 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 11.09 (1H, s)

HPLC : 6.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=541

Example 16-9)

$[\alpha]_D^{23} = -49.9^\circ$  (c 0.25, 1N-HCl aq.)

mp : 222-226°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.80 (1H, m), 1.16-1.55 (8H, m), 2.06-2.53 (10H, m), 2.57 (3H, d, J=4.5Hz), 2.65 (1H, m), 2.77 (1H, m), 2.83 (1H, dd, J=14, 10Hz), 2.96 (1H, dd,

J=14, 4Hz), 4.57 (1H, ddd, J=11, 8, 4Hz), 4.73 (1H, d, J=11Hz), 4.79 (1H, d, J=11Hz), 7.24 (2x1H, d, J=6Hz), 7.28-7.43 (5H, m), 7.74 (1H, dd, J=5, 5Hz), 7.86 (1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.39 (2x1H, d, J=6Hz), 11.03 (1H, s)

HPLC : 4.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=609

Example 16-10)

$[\alpha]_D^{23} = -20.7^\circ$  (c 0.23, 1N-HCl aq.)

mp : 215-219°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.69 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.80 (1H, m), 1.11-1.26 (1H, m), 1.20 (9H, s), 1.36 (1H, m), 2.17 (1H, m), 2.36 (1H, m), 2.57 (3H, d, J=5Hz), 2.68 (1H, m), 2.80-2.92 (1H, m), 2.86 (1H, dd, J=14, 10Hz), 2.98 (1H, dd, J=14, 6Hz), 4.55 (1H, ddd, J=10, 8, 6Hz), 4.66 (1H, d, J=12Hz), 4.71 (1H, d, J=12Hz), 5.44 (1H, dd, J=6, 6Hz), 5.66 (1H, s), 7.24 (2H, d, J=7Hz), 7.30-7.43 (5H, m), 7.82 (1H, q, J=5Hz), 8.26 (1H, d, J=8Hz), 8.41 (2H, d, J=7Hz), 11.10 (1H, s)

HPLC : 5.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=569

Example 16-11)

$[\alpha]_D^{24} = -38.3^\circ$  (c 0.12, 1N-HCl aq.)

mp : 237-243°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.80 (1H, m), 1.25 (1H, m), 1.36 (1H, m), 2.06 (3H, s), 2.20 (1H, m), 2.44 (1H, m), 2.56 (3H, d, J=5Hz), 2.68-2.90 (3H, m), 2.96 (1H, dd, J=14,

6Hz), 4.33 (1H, d, J=14Hz), 4.38 (1H, d, J=14Hz),  
4.56 (1H, ddd, J=10, 8, 6Hz), 4.71 (1H, d, J=11Hz),  
4.80 (1H, d, J=11Hz), 7.24 (2H, d, J=6Hz), 7.30-  
7.41 (5H, m), 7.76 (1H, dd, J=6, 6Hz), 7.86 (1H, q,  
J=5Hz), 8.34 (1H, d, J=8Hz), 8.39 (2H, d, J=6Hz),  
11.05 (1H, s)

HPLC : 6.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=570

Example 16-12)

$[\alpha]_D^{23} = -9.8^\circ$  (c 0.21, 1N-HCl aq.)

mp : 228-233°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.79 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.26 (1H, m), 1.33 (1H, m),  
2.15 (1H, m), 2.43 (1H, m), 2.45 (3H, d, J=4.5Hz),  
2.62-2.89 (3H, m), 2.95 (1H, dd, J=14, 4Hz), 3.47  
(3H, s), 4.56 (1H, ddd, J=10, 8, 4Hz), 4.70 (1H, d,  
J=12Hz), 4.77 (1H, d, J=12Hz), 6.77 (1H, dd, J=5,  
5Hz), 7.26 (2x1H, d, J=6Hz), 7.29-7.44 (5H, m),  
7.87 (1H, q, J=4.5Hz), 8.34 (1H, d, J=8Hz), 8.39  
(2x1H, d, J=6Hz), 10.98 (1H, s)

HPLC : 6.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=528

Example 16-13)

$[\alpha]_D^{23} = -38.7^\circ$  (c 0.21, 1N-HCl aq.)

mp : 233-236°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.79 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.25 (1H, m), 1.34 (1H, m),  
2.21 (1H, ddd, J=9, 9, 3Hz), 2.45 (1H, m), 2.56  
(3H, d, J=4.5Hz), 2.65 (1H, ddd, J=13, 5, 5Hz),

2.82 (1H, dd, J=14, 10Hz), 2.85 (1H, m), 2.95 (1H, dd, J=14, 5Hz), 3.27 (3H, s), 3.70 (2H, s), 4.55 (1H, ddd, J=10, 8, 5Hz), 4.71 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 7.25 (2x1H, d, J=6Hz), 7.27 (1H, dd, J=5, 5Hz), 7.31-7.40 (5H, m), 7.85 (1H, q, J=4.5Hz), 8.38 (2x1H, d, J=6Hz), 8.39 (1H, d, J=8Hz), 11.05 (1H, s)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=542

Example 16-14)

$[\alpha]_D^{23} = -18.4^\circ$  (c 0.23, 1N-HCl aq.)

mp : 239-243°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.82 (1H, m), 1.28 (1H, m), 1.35 (1H, m), 2.17 (1H, ddd, J=10, 9, 3Hz), 2.37-2.52 (2H, m), 2.56 (3H, d, J=4.5Hz), 2.67 (3H, s), 2.79-2.94 (1H, m), 2.84 (1H, dd, J=14, 10Hz), 2.93 (1H, dd, J=14, 5Hz), 4.51 (1H, ddd, J=10, 8, 5Hz), 4.77 (1H, d, J=11Hz), 4.81 (1H, d, J=11Hz), 6.84 (1H, dd, J=6, 6Hz), 7.27 (2x1H, d, J=7Hz), 7.31-7.44 (5H, m), 7.87 (1H, q, J=4.5Hz), 8.34 (1H, d, J=8Hz), 8.45 (2x1H, d, J=7Hz), 11.11 (1H, s)

HPLC : 5.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=548

Example 16-15)

$[\alpha]_D^{24} = -15.2^\circ$  (c 0.17, 1N-HCl aq.)

mp : 212-214°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.82 (1H, m), 1.26 (1H, m), 1.37 (1H, m),

2.24 (1H, m), 2.41 (1H, m), 2.57 (3H, d, J=4.5Hz),  
2.77 (2H, m), 2.85 (1H, dd, J=14, 11Hz), 2.97 (1H,  
dd, J=14, 6Hz), 4.58 (1H, ddd, J=11, 8, 6Hz), 4.73  
(1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 6.17 (1H, t,  
J=6Hz), 7.23-7.40 (9H, m), 7.87 (1H, q, J=4.5Hz),  
8.29 (2x1H, br d, J=5Hz), 8.34 (1H, d, J=8Hz), 8.41  
(2x1H, d, J=6Hz), 8.90 (1H, s), 11.18 (1H, s)

HPLC : 6.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=590

Example 16-16)

$[\alpha]_D^{24} = -6.3^\circ$  (c 0.13, 1N-HCl aq.)

mp : 227-229°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.73 (3H, d,  
J=7Hz), 0.84 (1H, m), 1.25 (1H, m), 1.38 (1H, m),  
2.31 (1H, m), 2.42 (1H, m), 2.44-2.55 (1H, m), 2.47  
(3H, d, J=4.5Hz), 2.62 (1H, dd, J=14, 8Hz), 2.74  
(1H, dd, J=14, 7Hz), 2.87 (1H, m), 4.42 (1H, ddd,  
J=8, 8, 7Hz), 4.79 (1H, d, J=11Hz), 4.83 (1H, d,  
J=11Hz), 7.07 (2x1H, d, J=6Hz), 7.31-7.47 (5H, m),  
7.50-7.63 (4H, m), 7.68-7.77 (2H, m), 7.80 (1H, q,  
J=4.5Hz), 8.26-8.40 (3H, m), 11.17 (1H, s)

HPLC : 6.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate  
1.0 ml/min., at R.T.)

MASS : M+H=610

Example 16-17)

$[\alpha]_D^{24} = -30.6^\circ$  (c 0.21, 1N-HCl aq.)

mp : 232-238°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.86 (1H,  
m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.32 (1H,  
m), 2.19 (1H, m), 2.40-2.58 (2H, m), 2.56 (3H, d,

J=4.5Hz), 2.82 (1H, dd, J=14, 12Hz), 2.88-3.02 (2H, m), 3.35-3.63 (4H, m), 3.90-4.00 (2H, m), 4.36 (1H, m), 4.52-4.68 (4H, m), 4.73 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 5.35 (1H, d, J=4Hz), 7.22-7.31 (1H, m), 7.25 (2x1H, d, J=6Hz), 7.32-7.42 (5H, m), 7.85 (1H, q, J=4.5Hz), 8.35-8.43 (1H, m), 8.40 (2x1H, d, J=6Hz), 11.00 (1H, s).

HPLC : 7.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=648

Example 16-18)

$[\alpha]_D^{24} = -48.0^\circ$  (c 0.27, AcOH)

mp : 218-220°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.82 (1H, m), 1.29 (1H, m), 1.37 (1H, m), 2.20 (1H, ddd, J=9, 9, 3Hz), 2.41-2.61 (2H, m), 2.57 (3H, d, J=4Hz), 2.70 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 6Hz), 4.60 (1H, ddd, J=11, 8, 6Hz), 4.74 (1H, d, J=11Hz), 4.81 (1H, d, J=11Hz), 7.09 (2x1H, d, J=7.5Hz), 7.18 (1H, dd, J=7.5, 7.5Hz), 7.27 (2x1H, d, J=6Hz), 7.31-7.52 (8H, m), 7.88 (1H, q, J=4Hz), 8.42 (2x1H, d, J=6Hz), 11.11 (1H, s)

HPLC : 7.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=590

Example 16-19)

$[\alpha]_D^{24} = +6.8^\circ$  (c 0.21, AcOH)

mp : 229-234°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.81 (3H, d, J=7Hz), 0.84 (1H, m), 1.29 (1H, m), 1.41 (1H, m),



2.34 (1H, ddd, J=11, 10, 3Hz), 2.46-2.65 (1H, m),  
2.58 (3H, d, J=4.5Hz), 2.78-2.93 (2H, m), 2.99 (1H,  
dd, J=14, 4Hz), 3.08 (1H, m), 4.56 (1H, d, J=11Hz),  
4.61 (1H, m), 4.75 (1H, d, J=11Hz), 7.02 (1H, dd,  
J=7.5, 7.5Hz), 7.10 (1H, s), 7.12-7.35 (8H, m),  
7.43 (1H, d, J=7.5Hz), 7.59 (1H, d, J=7.5Hz), 7.87  
(1H, q, J=4.5Hz), 8.12 (1H, dd, J=6, 6Hz), 8.38  
(2x1H, d, J=8Hz), 8.44 (1H, d, J=8Hz), 11.00 (1H,  
s), 11.45 (1H, s)

HPLC : 5.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=613

Example 16-20)

$[\alpha]_D^{24} = -36.9^\circ$  (c 0.24, AcOH)

mp : 250-256°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.84 (1H, m), 1.23 (1H, m), 1.40 (1H, m),  
2.32-2.54 (2H, m), 2.60 (3H, d, J=4.5Hz), 2.88 (1H,  
dd, J=14, 11Hz), 2.93-3.07 (3H, m), 4.50-4.67 (1H,  
m), 4.57 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz),  
7.02-7.31 (9H, m), 7.40 (1H, dd, J=8, 8Hz), 7.65  
(1H, dd, J=5, 5Hz), 7.90 (1H, q, J=4.5Hz), 8.02  
(1H, d, J=1Hz), 8.14 (1H, d, J=7.5Hz), 8.30-8.48  
(3H, m), 10.99 (1H, s), 11.48 (1H, d, J=1Hz)

HPLC : 4.2 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=613

Example 16-21)

$[\alpha]_D^{24} = -37.0^\circ$  (c 0.23, AcOH)

mp : 238-242°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.75-0.86 (1H,

m), 0.79 (3H, d, J=7Hz), 1.25 (1H, m), 1.33 (1H, m), 2.15 (1H, m), 2.45 (1H, m), 2.48-2.62 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.70 (1H, m), 2.82 (1H, dd, J=14, 11Hz), 2.95 (1H, dd, J=14, 5Hz), 3.23 (3H, s), 3.47 (2H, t, J=5Hz), 3.94-4.07 (2H, m), 4.57 (1H, ddd, J=11, 8, 5Hz), 4.70 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 6.80 (1H, dd, J=5, 5Hz), 7.25 (2x1H, d, J=6Hz), 7.32-7.42 (5H, m), 7.87 (1H, q, J=4.5Hz), 8.37 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 10.95 (1H, s)

HPLC : 7.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=572

#### Example 16-22)

$[\alpha]_D^{24} = -38.1^\circ$  (c 0.23, AcOH)

mp : 256-260°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.74-0.91 (1H, m), 0.79 (3H, d, J=7Hz), 0.85 (2x3H, d, J=7Hz), 1.26 (1H, m), 1.33 (1H, m), 1.80 (1H, tq, J=7, 7, 7Hz), 2.15 (1H, ddd, J=11, 9, 3Hz), 2.44 (1H, m), 2.46-2.60 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.70 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.93 (1H, dd, J=14, 6Hz), 3.68 (2H, d, J=7Hz), 4.56 (1H, ddd, J=11, 8, 6Hz), 4.69 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 6.70 (1H, dd, J=6, 6Hz), 7.25 (2x1H, d, J=7Hz), 7.30-7.41 (5H, m), 7.87 (1H, q, J=4.5Hz), 8.28 (1H, d, J=8Hz), 8.35 (1H, d, J=8Hz), 8.38 (2x1H, d, J=7Hz), 10.98 (1H, s)

HPLC : 7.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=570

Example 16-23) $[\alpha]_D^{24} = -73.6^\circ$  (c 0.25, AcOH)

mp : 253-258°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.53-0.65 (4H, m), 0.70 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.80 (1H, m), 1.23 (1H, m), 1.36 (1H, ddd, J=13, 11, 2Hz), 1.51 (1H, m), 2.20 (1H, ddd, J=11, 9, 3Hz), 2.41 (1H, ddd, J=11, 8, 3Hz), 2.56 (3H, d, J=4.5Hz), 2.63-2.90 (2H, m), 2.83 (1H, dd, J=14, 11Hz), 2.95 (1H, dd, J=14, 5Hz), 4.55 (1H, ddd, J=11, 8, 5Hz), 4.72 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 7.25 (2x1H, br d, J=6Hz), 7.30-7.43 (5H, m), 7.79 (1H, dd, J=5.5, 5.5Hz), 7.85 (1H, q, J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.39 (2H, br), 11.03 (1H, s)

HPLC : 6.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 254 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=538

Example 16-24) $[\alpha]_D^{23} = -12.3^\circ$  (c 0.20, 1N-HCl aq.)

mp : 222-231°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.74-0.87 (1H, m), 0.78 (3H, d, J=7Hz), 1.12 (2x3H, d, J=7Hz), 1.26 (1H, m), 1.33 (1H, m), 2.14 (1H, ddd, J=10, 9, 3Hz), 2.45 (1H, m), 2.47-2.61 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.70 (1H, m), 2.81 (1H, dd, J=14, 10Hz), 2.94 (1H, dd, J=14, 4Hz), 4.55 (1H, ddd, J=11, 8, 4Hz), 4.62-4.78 (1H, m), 4.68 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 6.56 (1H, dd, J=5.5, 5.5Hz), 7.25 (2x1H, d, J=6Hz), 7.28-7.42 (5H, m), 7.86 (1H, q, J=4.5Hz), 8.36 (1H, d, J=8Hz), 8.38 (2x1H, d, J=6Hz), 10.96 (1H, s)

HPLC : 9.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0

ml/min., at R.T.)

MASS : M+H=556

Example 16-25)

5  $[\alpha]_D^{23} = +17.0^\circ$  (c 0.21, 1N-HCl aq.)

mp : 237-241°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.83 (1H, m), 1.26 (1H, m), 1.38 (1H, m), 2.31 (1H, ddd, J=10, 9, 3Hz), 2.48 (1H, m), 2.58  
10 (3H, d, J=4.5Hz), 2.72-2.90 (1H, m), 2.87 (1H, dd, J=14, 11Hz), 2.94-3.10 (1H, m), 2.98 (1H, dd, J=14, 5Hz), 4.56 (1H, ddd, J=11, 8, 5Hz), 4.56 (1H, d, J=12Hz), 4.74 (1H, d, J=12Hz), 6.05 (1H, br), 6.75 (1H, br), 6.83 (1H, br), 7.20-7.35 (7H, m), 7.64  
15 (1H, dd, J=5.5, 5.5Hz), 7.87 (1H, q, J=4.5Hz), 8.38 (2x1H, d, J=6Hz), 8.40 (1H, d, J=6Hz), 10.95 (1H, s), 11.31 (1H, br)

HPLC : 8.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0  
20 ml/min., at R.T.)

MASS : M+H=563

Example 16-26)

$[\alpha]_D^{23} = +1.5^\circ$  (c 0.20, 1N-HCl aq.)

25 mp : 224-227°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.83 (1H, m), 1.27 (1H, m), 1.37 (1H, m), 2.36 (1H, ddd, J=9, 9, 4Hz), 2.47-2.60 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.80 (1H, m), 2.83 (1H, dd, J=14, 10Hz), 2.96 (1H, dd, J=14, 5Hz), 3.18 (1H, m), 4.57 (1H, m), 4.59 (1H, dd, J=12Hz), 4.71 (1H, d, J=12Hz), 7.21-7.31 (7H, m), 7.87 (1H, q, J=4.5Hz), 8.37 (2x1H, d, J=6Hz), 8.46 (1H, d, J=8Hz), 8.72 (1H, br), 8.87 (1H, d, J=2Hz), 9.15  
30 (1H, s), 11.05 (1H, s)

HPLC : 6.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=576

5

Example 16-27)

$[\alpha]_D^{23} = -29.4^\circ$  (c 0.20, 1N-HCl aq.)

mp : 225-229°C (dec.)

10 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.82 (1H, m), 1.12 (3H, t, J=7.5Hz), 1.28  
(1H, m), 1.36 (1H, m), 2.17 (1H, ddd, J=11, 9,  
3Hz), 2.32-2.53 (2H, m), 2.57 (3H, d, J=4.5Hz),  
2.72-2.93 (2H, m), 2.92 (1H, dd, J=14, 5Hz), 4.50  
(1H, m), 4.78 (1H, d, J=11Hz), 4.82 (1H, d,  
15 J=11Hz), 6.85 (1H, dd, J=6, 5Hz), 7.27 (2x1H, d,  
J=6Hz), 7.31-7.44 (5H, m), 7.88 (1H, q, J=4.5Hz),  
8.34 (1H, d, J=8Hz), 8.45 (2x1H, d, J=6Hz), 11.10  
(1H, s)

20 HPLC : 6.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=562

Example 16-28)

25  $[\alpha]_D^{23} = -1.3^\circ$  (c 0.26, 1N-HCl aq.)

mp : 225-231°C (dec.)

30 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.74-0.90 (1H,  
m), 0.78 (3H, d, J=7Hz), 1.26 (1H, m), 1.38 (1H,  
m), 2.31 (1H, ddd, J=10, 9, 3Hz), 2.45 (1H, m),  
2.57 (3H, d, J=4.5Hz), 2.71-3.05 (3H, m), 2.98 (1H,  
dd, J=14, 5Hz), 4.52-4.64 (1H, m), 4.58 (1H, d,  
J=12Hz), 4.74 (1H, d, J=12Hz), 6.83 (1H, s), 7.20-  
7.37 (7H, m), 7.70 (1H, s), 7.87 (1H, q, J=4.5Hz),  
7.95 (1H, dd, J=5.5, 5.5Hz), 8.13 (1H, s), 8.31-  
35 8.46 (3H, m), 11.00 (1H, s)

HPLC : 9.8 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=564

5

Example 16-29)

$[\alpha]_D^{23} = +26.8^\circ$  (c 0.23, 1N-HCl aq.)

mp : 236-241°C (dec.)

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.75-0.90 (1H,  
m), 0.80 (3H, d, J=7Hz), 1.26 (1H, m), 1.37 (1H,  
m), 2.32 (1H, ddd, J=10, 9, 3Hz), 2.42-2.55 (1H,  
m), 2.59 (3H, d, J=4.5Hz), 2.72 (1H, ddd, J=13,  
5.5, 5Hz), 2.84 (1H, dd, J=14, 11Hz), 2.91-3.06  
15 (1H, m), 2.96 (1H, dd, J=14, 5Hz), 4.57 (1H, d,  
J=11Hz), 4.58 (1H, ddd, J=11, 8, 5Hz), 4.73 (1H, d,  
J=11Hz), 6.60 (1H, dd, J=3, 2Hz), 7.08 (1H, d,  
J=3Hz), 7.22-7.37 (7H, m), 7.81 (1H, d, J=2Hz),  
7.88 (1H, q, J=4.5Hz), 7.96 (1H, dd, J=5.5, 5.5Hz),  
8.38 (2x1H, d, J=7Hz), 8.42 (1H, d, J=8Hz), 11.00  
20 (1H, s)

HPLC : 8.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=564

25

Example 16-30)

$[\alpha]_D^{25} = -35.8^\circ$  (c 0.22, 1N-HCl aq.)

mp : 250-257°C (dec.)

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.67-0.88 (1H, m), 0.73 (3H, d,  
J=7Hz), 0.80 (3H, d, J=7Hz), 1.27 (1H, m), 1.37  
(1H, m), 2.22 (1H, ddd, J=10, 10, 4Hz), 2.36-2.52  
(2H, m), 2.58 (3H, d, J=4.5Hz), 2.89 (1H, dd, J=14,  
11Hz), 3.04 (1H, dd, J=14, 5Hz), 4.65 (1H, ddd,  
J=11, 8, 5Hz), 4.66 (1H, d, J=11Hz), 4.76 (1H, d,  
35 J=11Hz), 7.35 (5x1H, s), 7.46 (2x1H, d, J=6Hz),

7.91 (1H, q, J=4.5Hz), 8.45 (1H, d, J=8Hz), 8.48  
(2x1H, br d, J=6Hz), 9.20 (1H, dd, J=5.5, 5.5Hz),  
11.16 (1H, s)

HPLC : 10.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=566

Example 16-31)

10  $[\alpha]_D^{25} = -69.3^\circ$  (c 0.28, 1N-HCl aq.)

mp : 258-265°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.74-0.89 (1H,  
m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.37 (1H,  
m), 1.85-2.28 (5H, m), 2.45 (1H, m), 2.54-2.81 (2H,  
15 m), 2.57 (3H, d, J=4.5Hz), 2.84 (1H, dd, J=14,  
11Hz), 2.97 (1H, dd, J=14, 5Hz), 3.91 (1H, m), 4.59  
(1H, m), 4.72 (1H, d, J=11Hz), 4.79 (1H, d,  
J=11Hz), 7.26 (2x1H, d, J=6Hz), 7.30-7.43 (5H, m),  
7.70-7.80 (2H, m), 7.92 (1H, q, J=4.5Hz), 8.32-8.46  
20 (3H, m), 11.11 (1H, s)

HPLC : 4.2 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=581

25

Example 16-32)

$[\alpha]_D^{23} = -1.5^\circ$  (c 0.08, 1N-HCl aq.)

mp : 222-229°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.74-0.86 (1H,  
30 m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.33 (1H,  
m), 2.13 (3H, ddd, J=9, 8Hz), 2.43 (1H, m), 2.45-  
2.60 (1H, m), 2.56 (3H, d, J=5Hz), 2.67 (1H, m),  
2.81 (1H, dd, J=14, 10Hz), 2.95 (1H, dd, J=14,  
4Hz), 3.21 (2H, m), 3.91 (2H, m), 4.57 (1H, ddd,  
35 J=10, 8, 4Hz), 4.70 (1H, d, J=11Hz), 4.77 (1H, d,

J=11Hz), 5.01 (2H, s), 6.74 (1H, dd, J=5, 5Hz),  
7.24 (2x1H, d, J=6Hz), 7.27-7.41 (11H, m), 7.86  
(1H, q, J=5Hz), 8.35 (1H, d, J=8Hz), 8.39 (2x1H, d,  
J=6Hz), 10.90 (1H, s)

5 HPLC : 6.2 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 35:65, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=691

10 Example 16-33)

$[\alpha]_D^{23} = -44.1^\circ$  (c 0.28, 1N-HCl aq.)

mp : 199-205°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.69 (3H, d, J=7Hz), 0.75 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.21 (1H, m), 1.35 (1H, m),  
15 1.88 (1H, m), 2.21 (1H, ddd, J=9, 9, 4Hz), 2.35-  
2.60 (2H, m), 2.55 (3H, d, J=4.5Hz), 2.66-2.90 (2H,  
m), 2.96 (1H, dd, J=14, 5Hz), 3.30 (2H, s), 4.55  
(1H, m), 4.64 (1H, d, J=11Hz), 4.75 (1H, d,  
J=11Hz), 6.87 (1H, br), 7.22 (2x1H, d, J=6Hz), 7.35  
20 (5x1H, s), 7.50 (1H, s), 7.72 (1H, dd, J=6, 6Hz),  
7.86 (1H, q, J=4.5Hz), 8.32-8.45 (3H, m), 11.21  
(1H, br)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
25 ml/min., at R.T.)

MASS : M+H=578

Example 16-34)

$[\alpha]_D^{23} = -44.4^\circ$  (c 0.10, 1N-HCl aq.)

30 mp : 263-270°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.72-0.86 (1H,  
m), 0.76 (3H, d, J=7Hz), 1.22 (1H, m), 1.35 (1H,  
m), 2.12-2.48 (6H, m), 2.53-2.70 (1H, m), 2.57 (3H,  
d, J=4.5Hz), 2.73-2.88 (2H, m), 2.96 (1H, dd, J=14,  
35 6Hz), 4.57 (1H, m), 4.71 (1H, d, J=11Hz), 4.80 (1H,



d, J=11Hz), 7.24 (2x1H, d, J=6Hz), 7.28-7.42 (5H, m), 7.60 (1H, dd, J=6, 6Hz), 7.85 (1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.38 (2x1H, d, J=6Hz), 10.98 (1H, s)

5 HPLC : 5.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=570

10 Example 16-35

$[\alpha]_D^{23} = -43.2^\circ$  (c 0.22, 1N-HCl aq.)

mp : 251-267°C (dec.)

15 NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.80 (1H, m), 1.23 (1H, m), 1.45 (1H, m), 1.84 (3H, s), 2.18 (1H, m), 2.45 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.71-2.90 (3H, m), 2.96 (1H, dd, J=14, 6Hz), 3.60 (2H, d, J=5Hz), 4.55 (1H, m), 4.72 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 7.23 (2x1H, d, J=6Hz), 7.30-7.43 (5H, m), 7.55 (1H, t, J=5Hz), 20 7.85 (1H, q, J=4.5Hz), 8.02 (1H, t, J=5Hz), 8.31 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 11.02 (1H, s)

HPLC : 4.8 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

25 MASS : M+H=569

Example 16-36

$[\alpha]_D^{23} = -36.7^\circ$  (c 0.23, 1N-HCl aq.)

30 mp : 250-253°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.74-0.88 (1H, m), 0.78 (3H, d, J=7Hz), 1.18-1.42 (2H, m), 2.21 (1H, ddd, J=10, 9, 4Hz), 2.47 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.63 (1H, ddd, J=13, 5, 4Hz), 2.82 (1H, dd, J=14, 11Hz), 2.84-3.01 (1H, m), 2.95 (1H, dd,

35

J=14, 5Hz), 3.46 (1H, m), 3.58 (1H, m), 3.83 (1H, m), 4.55 (1H, m), 4.71-4.90 (1H, m), 4.72 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 5.51 (1H, d, J=5Hz), 7.21-7.30 (1H, m), 7.25 (2x1H, d, J=6Hz), 7.32-7.42 (5H, m), 7.86 (1H, q, J=4.5Hz), 8.35-8.43 (1H, m), 8.39 (2x1H, d, J=6Hz), 11.06 (1H, s)

HPLC : 4.5 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=558

Example 16-37)

$[\alpha]_D^{23} = -21.9^\circ$  (c 0.23, 1N-HCl aq.)

mp : 214-221°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.69 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.81 (1H, m), 1.20 (1H, m), 1.36 (1H, m), 2.21 (1H, ddd, J=9, 9, 4Hz), 2.38 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.70-2.91 (3H, m), 2.96 (1H, dd, J=14, 6Hz), 3.61 (3H, s), 3.73-3.80 (2H, m), 4.54 (1H, m), 4.75 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.97 (1H, dd, J=6, 6Hz), 6.21 (1H, dd, J=6, 6Hz), 7.23 (2x1H, d, J=7Hz), 7.31-7.43 (5H, m), 7.83 (1H, q, J=4.5Hz), 8.26 (1H, d, J=8Hz), 8.41 (2x1H, d, J=7Hz), 11.09 (1H, s)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=585

Example 16-38)

$[\alpha]_D^{23} = -15.9^\circ$  (c 0.20, 1N-HCl aq.)

mp : 238-242°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.68 (3H, d, J=7Hz), 0.74 (3H, d, J=7Hz), 0.80 (1H, m), 1.20 (1H, m), 1.34 (1H, m), 2.20 (1H, ddd, J=9, 9, 4Hz), 2.37 (1H, m), 2.51

(3H, d, J=4.5Hz), 2.56 (3H, d, J=4.5Hz), 2.66-2.83  
(2H, m), 2.85 (1H, dd, J=14, 10Hz), 2.97 (1H, dd,  
J=14, 6Hz), 4.53 (1H, ddd, J=10, 8, 6Hz), 4.74 (1H,  
d, J=11Hz), 4.79 (1H, d, J=11Hz), 5.61 (1H, dd,  
J=6, 6Hz), 5.66 (1H, q, J=4.5Hz), 7.24 (2x1H, d,  
J=6Hz), 7.31-7.42 (5H, m), 7.85 (1H, q, J=4.5Hz),  
8.27 (1H, d, J=8Hz), 8.41 (2x1H, d, J=6Hz), 11.06  
(1H, s)

HPLC : 5.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=527

Example 16-39)

$[\alpha]_D^{23} = -56.2^\circ$  (c 0.22, 1N-HCl aq.)

mp : 243-247°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.76 (3H, d,  
J=7Hz), 0.80 (1H, m), 1.22 (1H, m), 1.34 (1H, m),  
2.20 (1H, ddd, J=9, 9, 4Hz), 2.47 (1H, m), 2.55  
(3H, d, J=4.5Hz), 2.69 (1H, m), 2.80-2.96 (1H, m),  
2.83 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14,  
5Hz), 3.45-3.63 (2H, m), 3.84 (1H, m), 4.53 (1H,  
ddd, J=11, 8, 5Hz), 4.72 (1H, d, J=11Hz), 4.79 (1H,  
d, J=11Hz), 4.89 (1H, br), 5.48 (1H, d, J=6Hz),  
7.23 (2x1H, d, J=6Hz), 7.30-7.40 (6H, m), 7.84 (1H,  
q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.39 (2x1H, d,  
J=6Hz), 11.10 (1H, s)

HPLC : 10.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=558

Example 16-40)

$[\alpha]_D^{23} = -45.3^\circ$  (c 0.20, 1N-HCl aq.)

mp : 254-259°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d,  $J=6.5\text{Hz}$ ), 0.74-0.90  
(1H, m), 0.78 (3H, d,  $J=6.5\text{Hz}$ ), 1.25 (1H, m), 1.38  
(1H, m), 2.19 (1H, m), 2.41 (1H, m), 2.57 (3H, d,  
 $J=4.5\text{Hz}$ ), 2.66-2.97 (3H, m), 2.95 (1H, dd,  $J=14$ ,  
5 6Hz), 3.11 (3H, s), 3.97 (2H, s), 4.60 (1H, m),  
4.74 (1H, d,  $J=11\text{Hz}$ ), 4.80 (1H, d,  $J=11\text{Hz}$ ), 7.25  
(2x1H, d,  $J=6\text{Hz}$ ), 7.31-7.42 (5H, m), 7.91 (1H, q,  
 $J=4.5\text{Hz}$ ), 8.14 (1H, dd,  $J=6$ , 6Hz), 8.36 (1H, d,  
 $J=8\text{Hz}$ ), 8.40 (2x1H, d,  $J=6\text{Hz}$ ), 11.12 (1H, s)

10 HPLC : 6.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M-H=588

15 Example 16-41)

$[\alpha]_D^{23} = -11.2^\circ$  (c 0.21, 1N-HCl aq.)

mp : 236-239°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d,  $J=7\text{Hz}$ ), 0.73-0.89 (1H,  
m), 0.78 (3H, d,  $J=7\text{Hz}$ ), 1.26 (1H, m), 1.33 (1H,  
20 m), 1.98 (3H, s), 2.14 (1H, m), 2.35-2.60 (2H, m),  
2.56 (3H, d,  $J=4.5\text{Hz}$ ), 2.69 (1H, m), 2.81 (1H, dd,  
 $J=13$ , 11Hz), 2.94 (1H, dd,  $J=13$ , 5Hz), 4.03-4.20  
(4H, m), 4.56 (1H, ddd,  $J=11$ , 8, 5Hz), 4.69 (1H, d,  
 $J=11\text{Hz}$ ), 4.76 (1H, d,  $J=11\text{Hz}$ ), 6.88 (1H, dd,  $J=5$ ,  
25 5Hz), 7.25 (2x1H, d,  $J=6\text{Hz}$ ), 7.30-7.42 (5H, m),  
7.87 (1H, q,  $J=4.5\text{Hz}$ ), 8.35 (1H, d,  $J=8\text{Hz}$ ), 8.39  
(2x1H, d,  $J=6\text{Hz}$ ), 10.96 (1H, s)

HPLC : 9.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 25:75, 260 nm, flow rate 1.0  
30 ml/min., at R.T.)

MASS : M+H=600

Example 16-42)

$[\alpha]_D^{25} = -55.4^\circ$  (c 0.23, AcOH)

35 mp : 231-234°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.73-0.86 (1H, m), 0.78 (3H, d, J=7Hz), 1.22 (1H, m), 1.28-1.42 (1H, m), 1.33 (3x3H, s), 2.42-2.60 (2H, m), 2.57 (3H, d, J=4.5Hz), 2.75 (1H, m), 2.80 (1H, dd, J=14, 10Hz), 2.97 (1H, dd, J=14, 5Hz), 3.54 (2H, dd, J=6, 6Hz), 3.97 (1H, dt, J=8, 6Hz), 4.62 (1H, m), 4.66 (1H, d, J=11Hz), 4.77 (1H, d, J=11Hz), 5.00 (1H, t, J=6Hz), 6.54 (1H, d, J=8Hz), 7.26 (2x1H, d, J=6Hz), 7.31-7.40 (5H, m), 7.59 (1H, dd, J=6, 6Hz), 7.90 (1H, q, J=4.5Hz), 8.33-8.41 (1H, m), 8.37 (2x1H, d, J=6Hz), 11.03 (1H, s)

HPLC : 5.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 30:70, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=657

Example 16-43)

$[\alpha]_D^{24} = -41.3^\circ$  (c 0.20, 1N-HCl aq.)

mp : 241-245°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.74-0.85 (1H, m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.36 (1H, m), 2.08-2.23 (2H, m), 2.30-2.54 (5H, m), 2.59 (3H, d, J=5Hz), 2.70 (1H, m), 2.80 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 4.60 (1H, m), 4.70 (1H, d, J=11Hz), 4.73-4.82 (1H, m), 4.78 (1H, d, J=11Hz), 7.26 (2x1H, d, J=6Hz), 7.31-7.40 (5H, m), 7.83-7.93 (2H, m), 8.31-8.42 (1H, m), 8.36 (2x1H, d, J=6Hz), 11.09 (1H, s)

HPLC : 6.8 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=582

Example 16-44)

$[\alpha]_D^{24} = -52.8^\circ$  (c 0.20, 1N-HCl aq.)

mp : 250-256°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.74-0.88 (1H, m), 0.79 (3H, d, J=7Hz), 1.27 (1H, m), 1.36 (1H, m), 2.02-2.25 (2H, m), 2.26-2.54 (5H, m), 2.57 (3H, d, J=5Hz), 2.63 (2H, m), 2.81 (1H, dd, J=13, 11Hz), 2.96 (1H, dd, J=13, 5Hz), 4.60 (1H, m), 4.70-4.83 (1H, m), 4.71 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 7.27 (2x1H, d, J=6Hz), 7.30-7.42 (5H, m), 7.83-7.98 (2H, m), 8.30-8.46 (3H, m), 11.09 (1H, s)

HPLC : 6.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:H<sub>2</sub>O:TFA= 25:75:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=582

Example 16-45)

$[\alpha]_D^{24} = -40.0^\circ$  (c 0.19, 1N-HCl aq.)

mp : 223-227°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.81 (1H, m), 1.25 (1H, m), 1.30-1.46 (1H, m), 1.36 (3x3H, s), 2.19 (1H, m), 2.45 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.70-2.90 (3H, m), 2.97 (1H, dd, J=14, 5Hz), 3.45 (1H, dd, J=15, 5Hz), 3.51 (1H, dd, J=15, 5Hz), 4.56 (1H, m), 4.72 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 6.81 (1H, dd, J=5, 5Hz), 7.24 (2x1H, d, J=6Hz), 7.28-7.42 (5H, m), 7.50 (1H, dd, J=5, 5Hz), 7.86 (1H, q, J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 11.03 (1H, s)

HPLC : 4.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:H<sub>2</sub>O:TFA = 35:65:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=627

Example 16-46)

$[\alpha]_D^{24} = -10.5^\circ$  (c 0.22, 1N-HCl aq.)

mp : 259-263°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d,  $J=7\text{Hz}$ ), 0.74-0.88 (1H, m), 0.78 (3H, d,  $J=7\text{Hz}$ ), 1.27 (1H, m), 1.33 (1H, m), 2.23 (1H, ddd,  $J=9, 9, 4\text{Hz}$ ), 2.45-2.60 (2H, m), 2.56 (3H, d,  $J=4.5\text{Hz}$ ), 2.82 (1H, dd,  $J=14, 11\text{Hz}$ ), 2.93 (1H, dd,  $J=14, 6\text{Hz}$ ), 3.02 (1H, m), 4.55 (1H, ddd,  $J=11, 8, 6\text{Hz}$ ), 4.66 (1H, d,  $J=11\text{Hz}$ ), 4.74 (1H, d,  $J=11\text{Hz}$ ), 7.25 (2x1H, d,  $J=6\text{Hz}$ ), 7.30-7.39 (5H, m), 7.80 (1H, br), 7.86 (1H, q,  $J=4.5\text{Hz}$ ), 8.01-8.10 (2H, m), 8.28 (2x1H, d,  $J=6\text{Hz}$ ), 8.35 (1H, d,  $J=8\text{Hz}$ ), 11.02 (1H, s)

HPLC : 5.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate  
1.0 ml/min., at R.T.)

MASS : M+H=541

Example 16-47)

$[\alpha]_D^{23} = -17.2^\circ$  (c 0.21, 1N-HCl aq.)

mp : 234-238°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d,  $J=7\text{Hz}$ ), 0.80 (3H, d,  $J=7\text{Hz}$ ), 0.83 (1H, m), 1.21-1.42 (2H, m), 2.17 (1H, ddd,  $J=9, 9, 3\text{Hz}$ ), 2.35-2.47 (2H, m), 2.56 (3H, d,  $J=4.5\text{Hz}$ ), 2.72 (3H, s), 2.77-3.00 (3H, m), 4.48 (1H, m), 4.77 (1H, d,  $J=11\text{Hz}$ ), 4.81 (1H, d,  $J=11\text{Hz}$ ), 6.83 (1H, dd,  $J=6, 6\text{Hz}$ ), 7.25-7.45 (5H, m), 7.30 (1H, dd,  $J=7.5, 5\text{Hz}$ ), 7.67 (1H, br d,  $J=7.5\text{Hz}$ ), 7.87 (1H, q,  $J=4.5\text{Hz}$ ), 8.33 (1H, d,  $J=8\text{Hz}$ ), 8.39 (1H, br d,  $J=5\text{Hz}$ ), 8.48 (1H, s), 11.10 (1H, s)

HPLC : 5.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=548

Example 16-48)

$[\alpha]_D^{24} = -36.9^\circ$  (c 0.22, 1N-HCl aq.)

mp : 228-230°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.74-0.85 (1H, m), 0.78 (3H, d, J=7Hz), 1.25 (1H, m), 1.35 (1H, m), 2.05 (3H, s), 2.16 (1H, m), 2.41 (1H, m), 2.46-2.61 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.71 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.95 (1H, dd, J=14, 5Hz), 4.30 (1H, d, J=15Hz), 4.37 (1H, d, J=15Hz), 4.51 (1H, m), 4.70 (1H, d, J=11Hz), 4.79 (1H, d, J=11Hz), 7.19 (1H, dd, J=7.5, 5Hz), 7.28-7.41 (5H, m), 7.63 (1H, br d, J=7.5Hz), 7.73 (1H, dd, J=5, 5Hz), 7.84 (1H, q, J=4.5Hz), 8.28-8.36 (2H, m), 8.43 (1H, s), 11.03 (1H, s)

HPLC : 6.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=570

Example 16-49)

$[\alpha]_D^{24} = -11.5^\circ$  (c 0.22, 1N-HCl aq.)

mp : 230-234°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.86 (1H, m), 0.78 (3H, d, J=7Hz), 1.13 (3H, t, J=7Hz), 1.20-1.40 (2H, m), 2.13 (1H, ddd, J=9, 9, 4Hz), 2.43 (1H, m), 2.45-2.59 (1H, m), 2.55 (3H, d, J=5Hz), 2.65 (1H, m), 2.80 (1H, dd, J=14, 11Hz), 2.93 (1H, dd, J=14, 5Hz), 3.92 (2H, q, J=7Hz), 4.52 (1H, m), 4.70 (1H, d, J=11Hz), 4.76 (1H, d, J=11Hz), 6.69 (1H, dd, J=5, 5Hz), 7.21 (1H, dd, J=7.5, 5Hz), 7.31-7.41 (5H, m), 7.65 (1H, br d, J=7.5Hz), 7.85 (1H, q, J=5Hz), 8.28-8.37 (2H, m), 8.44 (1H, br s), 10.96 (1H, s)

HPLC : 8.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=542



The following compounds were obtained in substantially the same manner as that of Example 12-5).

Example 17-1)

5 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-isobutyrylaminomethylsuccinyl]-L-4-pyridylalanine methylamide  
[ $\alpha$ ]<sub>D</sub><sup>25</sup> = -32.9° (c 0.19, 1N-HCl aq.)

mp : 249-252°C (dec.)

10 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.76 (3H, d, J=7Hz), 0.85 (1H, m), 0.93 (3H, d, J=7Hz), 0.94 (3H, d, J=7Hz), 1.22 (1H, m), 1.38 (1H, m), 2.14-2.32 (2H, m), 2.40 (1H, m), 2.55 (3H, d, J=4Hz), 2.60-2.89 (3H, m), 2.96 (1H, dd, J=14, 5Hz), 4.55 (1H, m), 7.19-7.32 (3H, m), 7.85 (1H, q, J=4Hz),  
15 8.30 (1H, d, J=8Hz), 8.36 (2x1H, d, J=6Hz), 8.70 (1H, s), 10.29 (1H, s)

HPLC : 5.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

20 MASS : M+H=450

Example 17-2)

25 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-pivaloylaminomethylsuccinyl]-L-4-pyridylalanine methylamide  
[ $\alpha$ ]<sub>D</sub><sup>23</sup> = -30.0° (c 0.21, 1N-HCl aq.)

mp : 226-229°C (dec.)

30 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.86 (1H, m), 1.04 (9H, s), 1.22 (1H, m), 1.37 (1H, m), 2.28 (1H, ddd, J=11, 10, 3Hz), 2.44 (1H, m), 2.53-2.65 (1H, m), 2.56 (3H, d, J=5Hz), 2.82-2.98 (1H, m), 2.84 (1H, dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 4.54 (1H, ddd, J=11, 8, 5Hz), 6.87 (1H, dd, J=5.5, 5.5Hz), 7.24 (2x1H, d, J=6Hz), 7.86 (1H, q, J=5Hz), 8.36 (1H, d, J=8Hz), 8.37 (2x1H, d, J=6Hz), 8.73 (1H, s), 10.29 (1H, s)

35

HPLC : 6.8 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M-H=462

5

Example 17-3)

N-[(2R,3R)-3-Ethoxycarbonylaminoethyl-4-hydroxyamino-2-  
isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -23.5^\circ$  (c 0.24, 1N-HCl aq.)

10

mp : 232-237°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.86 (1H, m), 1.14 (3H, t, J=7Hz), 1.27  
(1H, m), 1.38 (1H, m), 2.17 (1H, ddd, J=11, 9,  
3Hz), 2.42 (1H, m), 2.44-2.60 (1H, m), 2.56 (3H, d,  
J=5Hz), 2.76 (1H, m), 2.81 (1H, dd, J=13, 10Hz),  
2.95 (1H, dd, J=13, 5Hz), 3.92 (2H, q, J=7Hz), 4.55  
(1H, ddd, J=10, 8, 5Hz), 6.50 (1H, dd, J=5, 4Hz),  
7.25 (2H, d, J=7Hz), 7.85 (1H, q, J=5Hz), 8.32 (1H,  
d, J=8Hz), 8.40 (2H, d, J=7Hz), 8.76 (1H, s), 10.32  
(1H, s)

15

20

HPLC : 5.5 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=452

25

Example 17-4)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-methylcarbamoyl-  
acetamidomethylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -27.1^\circ$  (c 0.25, 1N-HCl aq.)

30

mp : 225-231°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.86 (1H, m), 1.22 (1H, m), 1.38 (1H, m),  
2.21 (1H, m), 2.44 (1H, m), 2.56 (3H, d, J=5Hz),  
2.60 (3H, d, J=4Hz), 2.70-2.81 (2H, m), 2.83 (1H,  
dd, J=14, 11Hz), 2.96 (1H, dd, J=14, 5Hz), 2.97

35

(2H, s), 4.55 (1H, m), 7.23 (2x1H, d, J=7Hz), 7.77 (1H, dd, J=5, 5Hz), 7.84-7.99 (2H, m), 8.34-8.43 (2H, m), 8.38 (2x1H, d, J=7Hz)

HPLC : 4.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=479

Example 17-5)

10 N-[(2R,3R)-3-Ethoxycarbonylacetamidomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -31.8^\circ$  (c 0.21, 1N-HCl aq.)

mp : 226-232°C (dec.)

15 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.87 (1H, m), 1.20 (3H, t, J=7Hz), 1.24 (1H, m), 1.40 (1H, m), 2.22 (1H, m), 2.42 (1H, m), 2.56 (3H, d, J=5Hz), 2.74-2.90 (3H, m), 2.96 (1H, dd, J=14, 5Hz), 3.13 (1H, d, J=15Hz), 3.18 (1H, d, J=15Hz), 4.07 (2H, q, J=7Hz), 4.56 (1H, m), 7.19-7.31 (2H, br), 7.72 (1H, dd, J=6, 6Hz), 7.85 (1H, q, J=5Hz), 8.25-8.48 (2H, br), 8.30 (1H, d, J=8Hz), 8.77 (1H, s), 10.38 (1H, s)

20 HPLC : 6.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=494

Example 17-6)

30 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(3-isopropyl-ureidomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -25.4^\circ$  (c 0.21, 1N-HCl aq.)

mp : 222-227°C (dec.)

35 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.88 (1H, m), 1.00 (2x3H, d, J=7Hz), 1.20

(1H, m), 1.39 (1H, m), 2.37 (1H, m), 2.57 (3H, d, J=5Hz), 2.75-2.84 (2H, m), 2.86 (1H, dd, J=14, 10Hz), 2.97 (1H, dd, J=14, 6Hz), 3.62 (1H, dq, J=7, 7, 7Hz), 4.54 (1H, ddd, J=10, 8, 6Hz), 5.35 (1H, dd, J=6, 6Hz), 5.72 (1H, d, J=7Hz), 7.25 (2x1H, br d, J=6Hz), 7.30-7.43 (5H, m), 7.84 (1H, q, J=5Hz), 8.25 (1H, d, J=8Hz), 8.42 (2x1H, br d, J=6Hz), 8.80 (1H, s), 10.46 (1H, s)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=465

Example 17-7)

N-[(2R,3R)-3-(3-Ethylureidomethyl)-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -25.3^\circ$  (c 0.25, 1N-HCl aq.)

mp : 237-243°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.69 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.87 (1H, m), 0.96 (3H, t, J=7Hz), 1.20 (1H, m), 1.38 (1H, m), 2.20 (1H, m), 2.37 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.70-3.04 (6H, m), 4.53 (1H, m), 5.44 (1H, t, J=6Hz), 5.80 (1H, t, J=5Hz), 7.25 (2x1H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz), 8.25 (1H, d, J=8Hz), 8.41 (2x1H, d, J=6Hz), 8.80 (1H, s), 10.45 (1H, s)

HPLC : 4.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=451

Example 17-8)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-[3-(piperidin-1-yl)propionylaminomethyl]succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -26.3^\circ$  (c 0.20, 1N-HCl aq.)

mp : 227-232°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.87 (1H, m), 1.24 (1H, m), 1.30-1.58 (7H, m), 2.10-2.25 (3H, m), 2.27-2.54 (7H, m), 2.57 (3H, d, J=5Hz), 2.72 (2H, t, J=6Hz), 2.83 (1H, dd, J=13, 10Hz), 2.96 (1H, dd, J=13, 4Hz), 4.55 (1H, ddd, J=10, 8, 4Hz), 7.24 (2x1H, d, J=6Hz), 7.68 (1H, dd, J=6, 5Hz), 7.86 (1H, q, J=5Hz), 8.29 (1H, d, J=8Hz), 8.38 (2x1H, d, J=6Hz), 8.74 (1H, br), 10.34 (1H, s)

HPLC : 4.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=519

Example 17-9)

N-[(2R,3R)-3-(3-tert-Butylureidomethyl)-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -27.2^\circ$  (c 0.22, 1N-HCl aq.)

mp : 196-200°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.88 (1H, m), 1.19 (1H, m), 1.20 (9H, s), 1.40 (1H, m), 2.17 (1H, m), 2.35 (1H, m), 2.57 (3H, d, J=5Hz), 2.73 (1H, m), 2.80-2.93 (2H, m), 2.98 (1H, dd, J=14, 4Hz), 4.54 (1H, m), 5.35 (1H, dd, J=5, 5Hz), 5.72 (1H, s), 7.25 (2x1H, d, J=6Hz), 7.83 (1H, q, J=5Hz), 8.26 (1H, d, J=8Hz), 8.42 (2x1H, d, J=6Hz), 8.82 (1H, br), 10.46 (1H, s)

HPLC : 5.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=479

Example 17-10)

N-[(2R,3R)-3-Acetoxyacetamidomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{24} = -26.4^\circ$  (c 0.25, 1N-HCl aq.)

mp : 230-236°C (dec.)

5 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.87 (1H, ddd, J=12, 9, 3Hz), 1.24 (1H, m), 1.39 (1H, ddd, J=12, 9, 3Hz), 2.08 (3H, s), 2.22 (1H, ddd, J=10, 10, 3Hz), 2.43 (1H, ddd, J=11, 11, 3Hz), 2.56 (3H, d, J=4.5Hz), 2.71 (1H, ddd, J=14, 5, 4Hz), 2.84 (1H, dd, J=14, 11Hz), 2.89 (1H, m), 10 2.97 (1H, dd, J=14, 6Hz), 4.35 (1H, d, J=12Hz), 4.40 (1H, d, J=12Hz), 4.55 (1H, ddd, J=11, 8, 6Hz), 7.25 (2x1H, d, J=6Hz), 7.58 (1H, dd, J=6, 5Hz), 7.86 (1H, q, J=4.5Hz), 8.32 (1H, d, J=8Hz), 8.40 15 (2x1H, d, J=6Hz), 8.80 (1H, s), 10.39 (1H, s)

HPLC : 4.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=548

20

Example 17-11)

N-[(2R,3R)-3-Carboxylacetamidomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -32.6^\circ$  (c 0.22, 1N-HCl aq.)

25 mp : 234-239°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.76 (3H, d, J=7Hz), 0.87 (1H, m), 1.23 (1H, m), 1.40 (1H, m), 2.21 (1H, m), 2.43 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.75-2.90 (3H, m), 2.96 (1H, dd, J=14, 6Hz), 3.06 30 (1H, d, J=15Hz), 3.11 (1H, d, J=15Hz), 4.56 (1H, m), 7.25 (2x1H, d, J=6Hz), 7.71 (1H, dd, J=5.5, 5.5Hz), 7.86 (1H, q, J=4.5Hz), 8.30 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.78 (1H, br), 10.37 (1H, s)

HPLC : 3.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,

35 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0

ml/min., at R.T.)

MASS : M+H=466

Example 17-12)

5 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(methoxycarbonyl-aminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -27.1^\circ$  (c 0.21, 1N-HCl aq.)

mp : 226-230°C (dec.)

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.87 (1H, m), 1.27 (1H, m), 1.38 (1H, m), 2.17 (1H, m), 2.31 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.68-2.89 (3H, m), 2.95 (1H, dd, J=14, 4Hz), 3.47 (3H, s), 4.56 (1H, m), 6.57 (1H, dd, J=5, 5Hz), 7.26 (2x1H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.75 (1H, s), 10.32 (1H, s)

HPLC : 4.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

20 MASS : M+H=438

Example 17-13)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(methoxy-acetamidomethyl)succinyl]-L-4-pyridylalanine methylamide

25  $[\alpha]_D^{23} = -20.4^\circ$  (c 0.35, 1N-HCl aq.)

mp : 241-244°C (dec.)

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.87 (1H, m), 1.26 (1H, m), 1.38 (1H, m), 2.24 (1H, ddd, J=10, 10, 3Hz), 2.45 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.62 (1H, ddd, J=12, 5, 4Hz), 2.83 (1H, dd, J=14, 11Hz), 2.90-3.05 (3H, m), 3.28 (3H, s), 3.71 (2H, s), 4.54 (1H, ddd, J=11, 8, 5Hz), 7.10 (1H, dd, J=5, 5Hz), 7.25 (2x1H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz), 8.36 (1H, d, J=8Hz), 8.39 (2x1H, d, J=6Hz), 8.81 (1H, s), 10.40 (1H, s)

HPLC : 4.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=452

5

Example 17-14)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(mesylamino-  
methyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{21} = -15.8^\circ$  (c 0.35, 1N-HCl aq.)

10

mp : 223-226°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.75 (3H, d, J=7Hz), 0.80 (3H, d,  
J=7Hz), 0.90 (1H, m), 1.31 (1H, m), 1.40 (1H, m),  
2.19 (1H, m), 2.35-2.48 (2H, m), 2.57 (3H, d,  
J=4.5Hz), 2.68 (3H, s), 2.80-2.95 (1H, m), 2.85  
(1H, dd, J=14, 11Hz), 2.94 (1H, dd, J=14, 5Hz),  
4.51 (1H, ddd, J=11, 7.5, 5Hz), 6.72 (1H, dd, J=7,  
5Hz), 7.29 (2x1H, d, J=7Hz), 7.88 (1H, q, J=4.5Hz),  
8.33 (1H, d, J=7.5Hz), 8.46 (2x1H, d, J=6Hz), 8.83  
(1H, s), 10.46 (1H, s)

15

20

HPLC : 3.8 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=458

25

Example 17-15)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-[3-(4-pyridyl)-  
ureidomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{24} = -44.6^\circ$  (c 0.27, 1N-HCl aq.)

mp : 223-229°C (dec.)

30

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d,  
J=7Hz), 0.90 (1H, m), 1.28 (1H, m), 1.41 (1H, m),  
2.24 (1H, ddd, J=10, 9, 3Hz), 2.42 (1H, ddd, J=10,  
10, 3Hz), 2.57 (3H, d, J=4.5Hz), 2.68-2.91 (2H, m),  
2.76 (1H, dd, J=14, 10Hz), 2.96 (1H, dd, J=14,  
5Hz), 4.57 (1H, ddd, J=10, 8, 5Hz), 6.10 (1H, dd,

35



J=6, 6Hz), 7.26 (2x1H, d, J=6Hz), 7.37 (2x1H, br d, J=5Hz), 7.87 (1H, q, J=4.5Hz), 8.21-8.36 (2H, m), 8.33 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.87 (1H, br), 9.00 (1H, s), 10.45 (1H, s)

5 HPLC : 4.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=500

10 Example 17-16)

N-[(2R,3R)-3-Benzenesulfonylaminomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{24} = -19.9^\circ$  (c 0.13, 1N-HCl aq.)

mp : 233-237°C (dec.)

15 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.90 (1H, m), 1.26 (1H, m), 1.42 (1H, m),  
2.25-2.51 (3H, m), 2.47 (3H, d, J=4.5Hz), 2.56 (1H, dd, J=14, 7Hz), 2.71 (1H, dd, J=14, 7Hz), 2.86 (1H, m),  
20 4.40 (1H, ddd, J=8, 7, 7Hz), 7.04 (2x1H, d, J=6Hz), 7.46 (1H, dd, J=7, 5Hz), 7.49-7.58 (3H, m),  
7.70 (1H, d, J=5Hz), 7.72 (1H, d, J=5Hz), 7.79 (1H, q, J=4.5Hz), 8.28 (1H, d, J=8Hz), 8.35 (2x1H, d, J=6Hz), 8.87 (1H, s), 10.49 (1H, s)

HPLC : 6.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
25 MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=520

Example 17-17)

30 N-[(2R,3R)-3-Glycoloylaminomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -20.0^\circ$  (c 0.38, 1N-HCl aq.)

mp : 221-226°C (dec.)

35 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.88 (1H, m), 1.26 (1H, m), 1.38 (1H, m),

2.24 (1H, ddd, J=9, 9, 4Hz), 2.41-2.53 (1H, m),  
2.55 (3H, d, J=4.5Hz), 2.71 (1H, ddd, J=13, 5,  
4Hz), 2.85 (1H, dd, J=14, 10Hz), 2.91-3.08 (1H, m),  
2.96 (1H, dd, J=14, 5Hz), 3.75 (2H, br), 4.54 (1H,  
5 ddd, J=10, 8, 5Hz), 5.46 (1H, br), 7.11 (1H, dd,  
J=6, 5Hz), 7.26 (2x1H, d, J=6Hz), 7.85 (1H, q,  
J=4.5Hz), 8.41 (2x1H, d, J=6Hz), 8.85 (1H, s),  
10.47 (1H, s)

HPLC : 3.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
10 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=438

Example 17-18)

15 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(phenoxycarbonyl-  
aminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -34.5^\circ$  (c 0.30, 1N-HCl aq.)

mp : 222-226°C (dec.)

20 NMR (DMSO-d<sub>6</sub>, δ) : 0.75 (3H, d, J=7Hz), 0.81 (3H, d,  
J=7Hz), 0.89 (1H, m), 1.29 (1H, m), 1.40 (1H, m),  
2.22 (1H, ddd, J=10, 9, 3Hz), 2.36-2.53 (2H, m),  
2.57 (3H, d, J=4.5Hz), 2.80 (1H, m), 2.82 (1H, dd,  
J=14, 11Hz), 2.95 (1H, dd, J=14, 4Hz), 4.60 (1H,  
ddd, J=11, 8, 4Hz), 7.11 (2x1H, d, J=7.5Hz), 7.19  
25 (1H, dd, J=7.5, 7.5Hz), 7.22-7.32 (3H, m), 7.38  
(2x1H, dd, J=7.5, 7.5Hz), 7.87 (1H, q, J=4.5Hz),  
8.35 (1H, d, J=8Hz), 8.42 (2x1H, br), 8.82 (1H, s),  
10.42 (1H, s)

HPLC : 3.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
30 MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=500

Example 17-19)

35 N-[(2R,3R)-4-Hydroxyamino-3-(2-indolylcarbonylamino-

methyl)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -24.3^\circ$  (c 0.30, 1N-HCl aq.)

mp : 234-238°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.75 (3H, d, J=7Hz), 0.82 (3H, d, J=7Hz), 0.92 (1H, ddd, J=13, 10, 3Hz), 1.30 (1H, m), 1.45 (1H, m), 2.39 (1H, ddd, J=10, 9, 3Hz), 2.46-2.65 (1H, m), 2.59 (3H, d, J=4.5Hz), 2.80 (1H, ddd, J=11, 4, 3Hz), 2.87 (1H, dd, J=14, 10Hz), 2.98 (1H, dd, J=14, 6Hz), 3.15 (1H, m), 4.59 (1H, ddd, J=10, 8, 6Hz), 7.02 (1H, dd, J=7.5, 7.5Hz), 7.05 (1H, s), 7.17 (1H, dd, J=7.5, 7.5Hz), 7.22-7.35 (2H, br), 7.42 (1H, d, J=7.5Hz), 7.60 (1H, d, J=7.5Hz), 7.89 (1H, q, J=4.5Hz), 7.95 (1H, dd, J=4, 4Hz), 8.29-8.50 (2H, br), 8.43 (1H, d, J=8Hz), 8.75 (1H, s), 10.37 (1H, s), 11.48 (1H, s)

HPLC : 6.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=523

#### Example 17-20)

N-[(2R,3R)-4-Hydroxyamino-3-(3-indolylcarbonylamino-methyl)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -25.4^\circ$  (c 0.25, 1N-HCl aq.)

mp : 218-222°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.92 (1H, m), 1.22 (1H, m), 1.44 (1H, m), 2.36-2.53 (2H, m), 2.59 (3H, d, J=4.5Hz), 2.88 (1H, dd, J=14, 10Hz), 2.90-3.15 (3H, m), 4.58 (1H, m), 7.08 (1H, dd, J=7.5, 7.5Hz), 7.14 (1H, dd, J=7.5, 7.5Hz), 7.26 (2x1H, d, J=6Hz), 7.41 (1H, d, J=7.5Hz), 7.90 (1H, q, J=4.5Hz), 7.96 (1H, d, J=2Hz), 8.11 (1H, d, J=7.5Hz), 8.32-8.45 (3H, m), 8.75 (1H, s), 10.38 (1H, s), 11.49 (1H, d, J=2Hz)

HPLC : 3.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,

MeCN:0.05% TFAaq. = 20:80, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=523

5 Example 17-21)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(2-methoxyethoxycarbonylaminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -19.5^\circ$  (c 0.30, 1N-HCl aq.)

mp : 223-227°C (dec.)

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.86 (1H, m), 1.26 (1H, m), 1.38 (1H, m), 2.17 (1H, ddd, J=10, 10, 3Hz), 2.43 (1H, m), 2.46-2.60 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.76 (1H, m), 2.81 (1H, dd, J=14, 11Hz), 2.93 (1H, dd, J=14, 5Hz), 3.25 (3H, s), 3.47 (2H, t, J=4Hz), 4.00 (2H, t, J=4Hz), 4.55 (1H, ddd, J=11, 8, 5Hz), 6.63 (1H, dd, J=5.5, 5.5Hz), 7.25 (2x1H, d, J=6Hz), 7.86 (1H, q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.39 (2x1H, d, J=6Hz), 8.76 (1H, s), 10.30 (1H, s)

20 HPLC : 5.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFAaq. = 10:90, 254 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=482

25 Example 17-22)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(isobutoxycarbonylaminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -25.4^\circ$  (c 0.31, 1N-HCl aq.)

mp : 232-236°C (dec.)

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.82-0.93 (1H, m), 0.88 (2x3H, d, J=7Hz), 1.26 (1H, m), 1.38 (1H, m), 1.82 (1H, tq, J=7, 7, 7Hz), 2.18 (1H, m), 2.33 (1H, m), 2.36-2.61 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.77 (1H, m), 2.82 (1H, dd, J=14, 10Hz), 2.94 (1H, dd, J=14, 6Hz), 3.68

(2H, d, J=7Hz), 4.55 (1H, ddd, J=10, 8, 6Hz), 6.50  
(1H, dd, J=6, 6Hz), 7.26 (2x1H, d, J=5Hz), 7.87  
(1H, q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.39 (2x1H,  
d, J=5Hz), 10.31 (1H, s)

5 HPLC : 5.8 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=480

10 Example 17-23)

N-[(2R,3R)-3-Cyclopropanecarbonylaminomethyl-4-hydroxy-  
amino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -37.9^\circ$  (c 0.29, 1N-HCl aq.)

mp : 236-241°C (dec.)

15 NMR (DMSO-d<sub>6</sub>, δ) : 0.52-0.66 (4H, m), 0.70 (3H, d,  
J=7Hz), 0.75 (3H, d, J=7Hz), 0.85 (1H, m), 1.20  
(1H, m), 1.38 (1H, m), 1.48 (1H, m), 2.20 (1H, ddd,  
J=11, 7, 7Hz), 2.39 (1H, ddd, J=11, 9, 3Hz), 2.54  
(3H, d, J=4.5Hz), 2.70-2.82 (2H, m), 2.84 (1H, dd,  
20 J=14, 11Hz), 2.95 (1H, dd, J=14, 5Hz), 4.54 (1H,  
ddd, J=11, 8, 5Hz), 7.22 (2H, br), 7.65 (1H, dd,  
J=5.5, 5.5Hz), 7.84 (1H, q, J=4.5Hz), 8.28 (1H, d,  
J=8Hz), 8.37 (2H, br), 8.76 (1H, s), 10.36 (1H, s)

HPLC : 4.6 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
25 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=448

Example 17-24)

30 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(isopropoxy-  
carbonylaminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -27.1^\circ$  (c 0.32, 1N-HCl aq.)

mp : 230-236°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d,  
35 J=7Hz), 0.86 (1H, m), 1.14 (2x3H, d, J=7Hz), 1.25

(1H, m), 1.37 (1H, m), 2.17 (1H, ddd, J=9, 9, 4Hz),  
2.42 (1H, m), 2.44-2.59 (1H, m), 2.56 (3H, d,  
J=4.5Hz), 2.75 (1H, m), 2.81 (1H, dd, J=14, 10Hz),  
2.93 (1H, dd, J=14, 5Hz), 4.54 (1H, ddd, J=10, 8,  
5Hz), 4.69 (1H, qq, J=7, 7Hz), 6.37 (1H, dd, J=5,  
5Hz), 7.25 (2x1H, d, J=6Hz), 7.84 (1H, q, J=4.5Hz),  
8.32 (1H, d, J=8Hz), 8.40 (2x1H, br d, J=6Hz), 8.75  
(1H, s), 10.29 (1H, s)

HPLC : 7.9 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=466

Example 17-25)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(2-pyrrolyl-  
carbonylaminomethyl)succinyl]-L-4-pyridylalanine methylamide  
[ $\alpha$ ]<sub>D</sub><sup>23</sup> = -23.0° (c 0.21, 1N-HCl aq.)

mp : 220-224°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.88 (1H, m), 1.25 (1H, m), 1.40 (1H, m),  
2.33 (1H, ddd, J=10, 9, 4Hz), 2.38-2.50 (1H, m),  
2.56 (3H, d, J=4.5Hz), 2.77 (1H, m), 2.85 (1H, dd,  
J=14, 11Hz), 2.95 (1H, dd, J=14, 4Hz), 3.08 (1H,  
m), 4.55 (1H, m), 6.03 (1H, dd, J=3, 3Hz), 6.67  
(1H, br), 6.81 (1H, br), 7.24 (2x1H, d, J=6Hz),  
7.44 (1H, dd, J=5.5, 5.5Hz), 7.87 (1H, q, J=4.5Hz),  
8.30-8.43 (3H, m), 8.73 (1H, s), 10.32 (1H, s),  
11.32 (1H, br)

HPLC : 8.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=473

Example 17-26)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(pyrazin-2-yl-

carbonylaminomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -22.8^\circ$  (c 0.25, 1N-HCl aq.)

mp : 234-238°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, ddd, J=13, 10, 3Hz), 1.29 (1H, m), 1.42 (1H, m), 2.39 (1H, ddd, J=10, 9, 4Hz), 2.48-2.62 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.76-2.91 (2H, m), 2.96 (1H, dd, J=14, 5Hz), 3.26 (1H, m), 4.57 (1H, m), 7.26 (2x1H, d, J=7Hz), 7.87 (1H, q, J=4.5Hz), 8.25 (1H, dd, J=5.5, 5.5Hz), 8.37 (2x1H, d, J=7Hz), 8.44 (1H, d, J=8Hz), 8.73 (1H, br), 8.83 (1H, s), 8.88 (1H, d, J=2Hz), 9.17 (1H, s), 10.46 (1H, s)

HPLC : 6.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=486

Example 17-27)

N-[(2R,3R)-3-Ethanesulfonylaminomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -22.3^\circ$  (c 0.24, 1N-HCl aq.)

mp : 240-246°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.89 (1H, ddd, J=13, 10, 3Hz), 1.10 (3H, t, J=7.5Hz), 1.30 (1H, m), 1.40 (1H, m), 2.18 (1H, ddd, J=13, 10, 3Hz), 2.32-2.47 (2H, m), 2.57 (3H, d, J=4.5Hz), 2.70 (2H, q, J=7.5Hz), 2.79-2.98 (3H, m), 4.50 (1H, m), 6.73 (1H, dd, J=6, 5Hz), 7.27 (2x1H, d, J=6Hz), 7.88 (1H, q, J=4.5Hz), 8.31 (1H, d, J=8Hz), 8.45 (2x1H, br d, J=6Hz), 8.81 (1H, s), 10.44 (1H, s)

HPLC : 4.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=472

Example 17-28)

5 N-[(2R,3R)-3-(3-Furoylaminomethyl)-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -25.0^\circ$  (c 0.28, 1N-HCl aq.)

mp : 225-228°C (dec.)

10 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.89 (1H, ddd, J=13, 11, 2.5Hz), 1.27 (1H, m), 1.41 (1H, ddd, J=13, 11, 2.5Hz), 2.34 (1H, ddd, J=10, 10, 4Hz), 2.45 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.73 (1H, ddd, J=13, 5.5, 4Hz), 2.86 (1H, dd, J=14, 10Hz), 2.92-3.08 (1H, m), 2.98 (1H, dd, J=14, 4Hz), 4.57 (1H, m), 6.80 (1H, s), 7.28 (2x1H, d, J=6Hz), 7.69 (1H, s), 7.75 (1H, dd, J=5.5, 5.5Hz), 7.87 (1H, q, J=4.5Hz), 8.11 (1H, s), 8.30-8.47 (3H, m), 8.72 (1H, s), 10.34 (1H, s)

15

HPLC : 6.4 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

20

MASS : M+H=474

Example 17-29)

25 N-[(2R,3R)-3-(2-Furoylaminomethyl)-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -22.8^\circ$  (c 0.23, 1N-HCl aq.)

mp : 231-235°C (dec.)

30 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.89 (1H, m), 1.27 (1H, m), 1.41 (1H, m), 2.35 (1H, ddd, J=10, 9, 4Hz), 2.43-2.55 (1H, m), 2.57 (3H, d, J=4.5Hz), 2.70 (1H, ddd, J=12, 5.5, 4Hz), 2.84 (1H, dd, J=13, 11Hz), 2.95 (1H, dd, J=13, 5Hz), 3.08 (1H, m), 4.56 (1H, ddd, J=11, 8, 5Hz), 6.60 (1H, dd, J=3, 2Hz), 7.05 (1H, d, J=3Hz), 7.25 (2x1H, d, J=6Hz), 7.73 (1H, dd, J=5.5, 5.5Hz),

35



7.80 (1H, d, J=2Hz), 7.87 (1H, q, J=4.5Hz), 8.36  
(2x1H, d, J=6Hz), 8.40 (1H, d, J=8Hz), 8.77 (1H,  
s), 10.37 (1H, s)

HPLC : 7.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=474

Example 17-30)

10 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(trifluoro-  
acetamidomethyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{25} = -24.9^\circ$  (c 0.24, 1N-HCl aq.)

mp : 223-227°C (dec.)

15 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.84 (1H, m), 1.28 (1H, m), 1.39 (1H, m),  
2.24 (1H, ddd, J=9, 9, 3Hz), 2.30-2.52 (2H, m),  
2.57 (3H, d, J=4.5Hz), 2.81 (1H, dd, J=14, 11Hz),  
2.89 (1H, m), 2.96 (1H, dd, J=14, 4Hz), 4.60 (1H,  
m), 7.29 (2x1H, d, J=6Hz), 7.88 (1H, q, J=4.5Hz),  
20 8.29-8.45 (3H, m), 8.78 (1H, s), 9.02 (1H, dd, J=5,  
5Hz), 10.41 (1H, s)

HPLC : 5.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

25 MASS : M+H=476

Example 17-31)

30 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-[(S)-2-  
pyrrolidon-5-ylcarbonylaminomethyl)succinyl]-L-4-  
pyridylalanine methylamide

$[\alpha]_D^{22} = -36.5^\circ$  (c 0.22, 1N-HCl aq.)

mp : 248-254°C (dec.)

35 NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d,  
J=7Hz), 0.87 (1H, m), 1.26 (1H, m), 1.40 (1H, m),  
1.83-2.30 (5H, m), 2.40 (1H, m), 2.55-2.65 (1H, m),

2.58 (3H, d, J=4.5Hz), 2.72 (1H, m), 2.87 (1H, dd, J=14, 11Hz), 3.00 (1H, dd, J=14, 5Hz), 3.91 (1H, m), 4.59 (1H, ddd, J=11, 8, 5Hz), 7.36 (2x1H, d, J=6Hz), 7.61 (1H, dd, J=6, 6Hz), 7.68 (1H, s), 7.90 (1H, q, J=4.5Hz), 8.35 (1H, d, J=8Hz), 8.44 (2x1H, d, J=6Hz), 8.74 (1H, s), 10.38 (1H, s)

HPLC : 4.3 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=491

Example 17-32)

N-[(2R,3R)-4-Hydroxyamino-3-(imidazol-4-ylacetylaminomethyl)-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -28.1^\circ$  (c 0.23, 1N-HCl aq.)

mp : 234-242°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.71 (3H, d, J=7Hz), 0.76 (3H, d, J=7Hz), 0.86 (1H, m), 1.23 (1H, m), 1.38 (1H, m), 2.21 (1H, ddd, J=9, 9, 4Hz), 2.45 (1H, m), 2.55 (3H, d, J=4.5Hz), 2.67-2.90 (3H, m), 2.95 (1H, dd, J=14, 6Hz), 3.30 (2H, s), 4.53 (1H, m), 6.90 (1H, s), 7.23 (2x1H, d, J=6Hz), 7.52 (2H, dd, J=6, 6Hz), 7.63 (1H, s), 7.85 (1H, q, J=4.5Hz), 8.31-8.43 (3H, m), 10.46 (1H, s)

HPLC : 3.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=488

Example 17-33)

N-[(2R,3R)-3-(3-Carboxypropionylaminomethyl)-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -32.4^\circ$  (c 0.26, 1N-HCl aq.)

mp : 215-221°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d,

J=7Hz), 0.86 (1H, m), 1.22 (1H, m), 1.38 (1H, m),  
2.13-2.47 (6H, m), 2.57 (3H, d, J=4.5Hz), 2.68-2.78  
(2H, m), 2.83 (1H, dd, J=14, 11Hz), 2.96 (1H, dd,  
J=14, 6Hz), 4.57 (1H, ddd, J=11, 8, 6Hz), 7.23  
(2x1H, d, J=6Hz), 7.47 (1H, dd, J=5.5, 5.5Hz), 7.86  
(1H, q, J=4.5Hz), 8.30 (1H, d, J=8Hz), 8.40 (2x1H,  
d, J=6Hz), 8.74 (1H, br), 10.31 (1H, s)

HPLC : 3.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=480

Example 17-34)

N-[(2R,3R)-3-(N-Acetylglycyl)aminomethyl-4-hydroxyamino-  
2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{22} = -18.7^\circ$  (c 0.37, 1N-HCl aq.)

mp : 225-233°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.86 (1H, m), 1.24 (1H, m), 1.39 (1H, m),  
1.87 (3H, s), 2.20 (1H, m), 2.45 (1H, m), 2.54 (3H,  
d, J=4.5Hz), 2.73 (1H, m), 2.83-2.96 (2H, m), 2.85  
(1H, dd, J=14, 10Hz), 2.96 (1H, dd, J=14, 7Hz),  
3.60 (2H, d, J=6Hz), 4.53 (1H, ddd, J=10, 8, 7Hz),  
7.23 (2x1H, d, J=6Hz), 7.44 (1H, dd, J=5.5, 5.5Hz),  
7.84 (1H, q, J=4.5Hz), 8.09 (1H, t, J=6Hz), 8.26  
(1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.79 (1H,  
s), 10.39 (1H, s)

HPLC : 4.3 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=479

Example 17-35)

N-[(2R,3R)-3-[(2R)-Glyceroylaminomethyl]-4-hydroxyamino-  
2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -7.6^\circ$  (c 0.41, 1N-HCl aq.)

mp : 214-220°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.87 (1H, m), 1.25 (1H, m), 1.38 (1H, m),  
5 2.23 (1H, ddd, J=9, 9, 4Hz), 2.47 (1H, m), 2.55  
(3H, d, J=4.5Hz), 2.61 (1H, ddd, J=13, 5, 4Hz),  
2.83 (1H, dd, J=13, 11Hz), 2.91-3.06 (1H, m), 2.95  
(1H, dd, J=13, 6Hz), 3.45 (1H, m), 3.58 (1H, m),  
3.83 (1H, m), 4.54 (1H, ddd, J=11, 8, 6Hz), 4.73  
10 (1H, dd, J=6, 6Hz), 5.50 (1H, d, J=5Hz), 7.15 (1H,  
dd, J=5.5, 5.5Hz), 7.24 (2x1H, d, J=6Hz), 7.84 (1H,  
q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.40 (2x1H, d,  
J=6Hz), 8.84 (1H, s), 10.43 (1H, s)

HPLC : 4.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
15 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=468

Example 17-36)

20 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-[(3-methoxy-  
carbonylmethyl)ureidomethyl]succinyl]-L-4-pyridylalanine  
methanamide

$[\alpha]_D^{22} = -27.4^\circ$  (c 0.31, 1N-HCl aq.)

mp : 210-214°C (dec.)

25 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.74 (3H, d,  
J=7Hz), 0.87 (1H, m), 1.20 (1H, m), 1.39 (1H, m),  
2.21 (1H, ddd, J=10, 9, 4Hz), 2.38 (1H, ddd, J=11,  
10, 2Hz), 2.54 (3H, d, J=4.5Hz), 2.71-2.92 (3H, m),  
2.97 (1H, dd, J=14, 5Hz), 3.61 (3H, s), 3.75 (2H,  
30 d, J=6Hz), 4.53 (1H, m), 5.97 (1H, dd, J=6, 6Hz),  
6.26 (1H, t, J=6Hz), 7.22 (2x1H, d, J=7Hz), 7.83  
(1H, q, J=4.5Hz), 8.24 (1H, d, J=8Hz), 8.40 (2x1H,  
d, J=7Hz), 8.81 (1H, s), 10.45 (1H, s)

HPLC : 5.2 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
35 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0

ml/min., at R.T.)

MASS : M+H=495

Example 17-37)

5 N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(3-methylureido-methyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -22.1^\circ$  (c 0.36, 1N-HCl aq.)

mp : 223-226°C (dec.)

10 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.70 (3H, d, J=7Hz), 0.74 (3H, d, J=7Hz), 0.87 (1H, m), 1.20 (1H, m), 1.38 (1H, m), 2.20 (1H, m), 2.38 (1H, ddd, J=10, 10, 3Hz), 2.51 (3H, d, J=4.5Hz), 2.56 (3H, d, J=4.5Hz), 2.80 (2H, t, J=6Hz), 2.86 (1H, dd, J=14, 10Hz), 2.97 (1H, dd, J=14, 6Hz), 4.53 (1H, ddd, J=10, 8, 6Hz), 5.49 (1H, t, J=6Hz), 5.71 (1H, q, J=4.5Hz), 7.23 (2x1H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz), 8.28 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.78 (1H, s), 10.43 (1H, s)

15 HPLC : 4.0 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

20 MASS : M+H=437

Example 17-38)

25 N-((2R,3R)-4-Hydroxyamino-2-isobutyl-3-[3-(methyl-carbamoylmethyl)ureidomethyl]succinyl)-L-4-pyridylalanine methylamide

$[\alpha]_D^{21} = -26.2^\circ$  (c 0.28, 1N-HCl aq.)

mp : 233-237°C (dec.)

30 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.75 (3H, d, J=7Hz), 0.87 (1H, m), 1.21 (1H, m), 1.38 (1H, m), 2.17 (1H, ddd, J=10, 9, 4Hz), 2.38 (1H, ddd, J=10, 10, 3Hz), 2.53-2.69 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.60 (3H, d, J=4.5Hz), 2.70-2.86 (1H, m), 2.84 (1H, dd, J=14, 10Hz), 2.99 (1H, dd, J=14, 5Hz), 3.53 (1H, dd, J=17, 6Hz), 3.58 (1H, dd, J=17, 6Hz), 4.54

(1H, ddd, J=10, 8, 5Hz), 5.80 (1H, dd, J=6, 6Hz),  
6.17 (1H, dd, J=6, 6Hz), 7.25 (2x1H, d, J=6Hz),  
7.74 (1H, q, J=4.5Hz), 7.85 (1H, q, J=4.5Hz), 8.25  
(1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 8.80 (1H,  
s), 10.43 (1H, s)

HPLC : 4.3 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=494

Example 17-39)

N-[(2R,3R)-3-[(2S)-Glyceroylaminomethyl]-4-hydroxyamino-  
2-isobutylsuccinyl)-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -33.2^\circ$  (c 0.36, 1N-HCl aq.)

mp : 211-220°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=6.3Hz), 0.76 (3H, d,  
J=6.3Hz), 0.86 (1H, m), 1.24 (1H, m), 1.40 (1H, m),  
2.23 (1H, m), 2.40-2.62 (1H, m), 2.54 (3H, d,  
J=4.5Hz), 2.70 (1H, m), 2.78-3.10 (3H, m), 3.46-  
3.66 (2H, m), 3.85 (1H, m), 4.52 (1H, m), 5.00 (1H,  
br), 5.48 (1H, d, J=6.2Hz), 7.23 (2x1H, d,  
J=5.5Hz), 7.29 (1H, m), 7.81 (1H, q, J=4.5Hz), 8.28  
(1H, d, J=8.1Hz), 8.39 (2x1H, d, J=5.5Hz), 8.85  
(1H, s), 10.48 (1H, s)

HPLC : 4.2 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=468

Example 17-40)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(methanesulfonyl-  
acetylaminomethyl)succinyl)-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -26.0^\circ$  (c 0.36, 1N-HCl aq.)

mp : 247-252°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.73 (3H, d, J=7Hz), 0.78 (3H, d,

J=7Hz), 0.87 (1H, m), 1.25 (1H, m), 1.41 (1H, m),  
2.20 (1H, m), 2.41 (1H, m), 2.56 (3H, d, J=4.5Hz),  
2.70-2.87 (2H, m), 2.84 (1H, dd, J=14, 12Hz), 2.96  
(1H, dd, J=14, 5Hz), 3.10 (3H, s), 3.98 (2H, s),  
4.58 (1H, ddd, J=12, 8, 5Hz), 7.24 (2x1H, d,  
J=6Hz), 7.87 (1H, q, J=4.5Hz), 8.02 (1H, dd, J=6,  
6Hz), 8.28 (1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz),  
8.77 (1H, s), 10.40 (1H, s)

HPLC : 4.5 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=500

Example 17-41)

N-[(2R,3R)-3-(2-Acetoxyethoxy)carbonylaminomethyl-4-  
hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine  
methanamide

$[\alpha]_D^{23} = -19.8^\circ$  (c 0.34, 1N-HCl aq.)

mp : 223-228°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d,  
J=7Hz), 0.86 (1H, m), 1.27 (1H, m), 1.38 (1H, m),  
2.02 (3H, s), 2.17 (1H, m), 2.35-2.61 (2H, m), 2.56  
(3H, d, J=4.5Hz), 2.76 (1H, m), 2.81 (1H, dd, J=14,  
11Hz), 2.94 (1H, dd, J=14, 5Hz), 4.03-4.20 (4H, m),  
4.56 (1H, ddd, J=11, 8, 5Hz), 6.70 (1H, dd, J=5,  
5Hz), 7.24 (2H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz),  
8.32 (1H, d, J=8Hz), 8.38 (2H, d, J=6Hz), 8.75 (1H,  
s), 10.30 (1H, s)

HPLC : 8.2 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=510

Example 17-42)

N-[(2R,3R)-4-Hydroxyamino-3-(2-hydroxyethoxy)carbonyl-

aminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine  
methanamide

$[\alpha]_D^{23} = -22.4^\circ$  (c 0.32, 1N-HCl aq.)

mp : 215-219°C (dec.)

5 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d,  
J=7Hz), 0.87 (1H, m), 1.27 (1H, m), 1.38 (1H, m),  
2.17 (1H, ddd, J=9, 9, 4Hz), 2.43 (1H, m), 2.45-  
2.60 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.70-2.84 (1H,  
m), 2.82 (1H, dd, J=14, 11Hz), 2.94 (1H, dd, J=14,  
10 5Hz), 3.53 (2H, t, J=4Hz), 3.90 (2H, t, J=4Hz),  
4.56 (1H, ddd, J=11, 8, 5Hz), 4.75 (1H, br), 6.52  
(1H, dd, J=5, 5Hz), 7.25 (2x1H, d, J=6Hz), 7.86  
(1H, q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.40 (2x1H,  
d, J=6Hz), 8.77 (1H, s), 10.31 (1H, s)

15 HPLC : 4.4 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=468

20 Example 17-43)

N-[(2R,3R)-3-[(2S)-2-tert-Butoxycarbonylamino-3-hydroxy-  
propionyl]aminomethyl]-4-hydroxyamino-2-isobutylsuccinyl]-L-  
4-pyridylalanine methanamide

$[\alpha]_D^{23} = -38.1^\circ$  (c 0.38, 1N-HCl aq.)

25 mp : 214-217°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.77 (3H, d,  
J=7Hz), 0.85 (1H, m), 1.23 (1H, m), 1.31-1.47 (1H,  
m), 1.39 (9H, s), 2.15 (1H, m), 2.41-2.70 (2H, m),  
2.56 (3H, d, J=4.5Hz), 2.70-2.84 (1H, m), 2.81 (1H,  
30 dd, J=13, 10Hz), 2.97 (1H, dd, J=13, 5Hz), 3.53  
(2H, br d, J=5Hz), 3.95 (1H, dt, J=8, 5Hz), 4.60  
(1H, ddd, J=10, 8, 5Hz), 6.50 (1H, d, J=8Hz), 7.26  
(2x1H, d, J=6Hz), 7.52 (1H, dd, J=5, 5Hz), 7.90  
(1H, q, J=4.5Hz), 8.33 (1H, d, J=8Hz), 8.39 (2x1H,  
35 d, J=6Hz), 8.79 (1H, s), 10.36 (1H, s)



HPLC : 5.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=567

5

Example 17-44)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(methanesulfonyl-  
aminomethyl)succinyl]-L-3-pyridylalanine methylamide

$[\alpha]_D^{23} = -19.4^\circ$  (c 0.31, 1N-HCl aq.)

10 mp : 230-233°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.80 (3H, d,  
J=7Hz), 0.90 (1H, m), 1.22-1.48 (2H, m), 2.17 (1H,  
m), 2.30-2.46 (2H, m), 2.55 (3H, d, J=5Hz), 2.70  
(3H, s), 2.77-3.00 (3H, m), 4.47 (1H, m), 6.70 (1H,  
15 dd, J=5, 5Hz), 7.03 (1H, dd, J=7.5, 5Hz), 7.68 (1H,  
br d, J=7.5Hz), 7.85 (1H, q, J=5Hz), 8.30 (1H, d,  
J=8Hz), 8.39 (1H, br), 8.47 (1H, s), 8.82 (1H, s),  
10.43 (1H, s)

HPLC : 4.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
20 MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=458

Example 17-45)

25 N-[(2R,3R)-3-Acetoxyacetylaminomethyl-4-hydroxyamino-2-  
isobutylsuccinyl]-L-3-pyridylalanine methylamide

$[\alpha]_D^{24} = -26.9^\circ$  (c 0.25, 1N-HCl aq.)

mp : 206-208°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.79 (3H, d,  
30 J=7Hz), 0.86 (1H, m), 1.25 (1H, m), 1.38 (1H, m),  
2.08 (3H, s), 2.20 (1H, ddd, J=9, 9, 4Hz), 2.42  
(1H, ddd, J=10, 9, 2Hz), 2.47-2.60 (1H, m), 2.55  
(3H, d, J=4.5Hz), 2.75-2.90 (2H, m), 2.95 (1H, dd,  
J=14, 6Hz), 4.34 (1H, d, J=15Hz), 4.38 (1H, d,  
35 J=15Hz), 4.51 (1H, m), 7.20 (1H, dd, J=7.5, 5Hz),

7.56 (1H, dd, J=6, 6Hz), 7.63 (1H, br d, J=7.5Hz),  
7.84 (1H, q, J=4.5Hz), 8.29 (1H, d, J=8Hz), 8.33  
(1H, d, J=5Hz), 8.43 (1H, s), 8.78 (1H, s), 10.37  
(1H, s)

5 HPLC : 5.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=480

10 Example 17-46)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-[(2R)-5-oxo-  
tetrahydrofuran-2-ylcarbonylaminomethyl]succinyl]-L-4-  
pyridylalanine methylamide methanesulfonate

$[\alpha]_D^{24} = -13.4^\circ$  (c 0.35, 1N-HCl aq.)

15 mp : 197-204°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d,  
J=7Hz), 0.88 (1H, m), 1.27 (1H, m), 1.38 (1H, m),  
2.09 (1H, m), 2.15 (1H, ddd, J=9, 9, 3Hz), 2.28-  
2.53 (5H, m), 2.30 (3H, s), 2.60 (3H, d, J=5Hz),  
20 2.78 (1H, m), 3.07 (1H, dd, J=13, 11Hz), 3.22 (1H,  
dd, J=13, 5Hz), 4.60 (1H, m), 4.70 (1H, ddd, J=11,  
8, 5Hz), 4.78 (1H, dd, J=8, 6Hz), 7.73 (1H, dd,  
J=6, 5Hz), 7.85-7.98 (1H, m), 7.91 (2x1H, d,  
J=6Hz), 8.42 (1H, d, J=8Hz), 8.75 (2x1H, d, J=6Hz),  
25 10.46 (1H, s)

HPLC : 4.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=492

30

Example 17-47)

N-[(2R,3R)-3-Hydroxyacetylaminomethyl-4-hydroxyamino-2-  
isobutylsuccinyl]-L-3-pyridylalanine methylamide  
methanesulfonate

35  $[\alpha]_D^{24} = -17.5^\circ$  (c 0.30, 1N-HCl aq.)

mp : 169-171°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.75 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.89 (1H, m), 1.28 (1H, m), 1.38 (1H, m), 2.16 (1H, ddd, J=10, 9, 4Hz), 2.32 (3H, s), 2.35-2.53 (2H, m), 2.60 (3H, d, J=5Hz), 2.85 (1H, m), 3.00 (1H, dd, J=14, 11Hz), 3.15 (1H, dd, J=14, 4Hz), 3.72 (1H, d, J=16Hz), 3.76 (1H, d, J=16Hz), 4.60 (1H, m), 7.05 (1H, dd, J=5, 5Hz), 7.85-7.96 (2H, m), 8.32-8.45 (2H, m), 8.70 (1H, d, J=5Hz), 8.78 (1H, s), 10.52 (1H, s)

HPLC : 4.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=438

Example 17-48)

N-((2R,3R)-4-Hydroxyamino-2-isobutyl-3-[(2S)-5-oxotetrahydrofuran-2-ylcarbonylaminoethyl]succinyl)-L-4-pyridylalanine methylamide methanesulfonate

$[\alpha]_D^{24} = -27.1^\circ$  (c 0.27, 1N-HCl aq.)

mp : 210-214°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.77 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.87 (1H, m), 1.27 (1H, m), 1.38 (1H, m), 2.05 (1H, m), 2.19 (1H, ddd, J=9, 9, 3Hz), 2.30-2.53 (5H, m), 2.32 (3H, s), 2.60 (3H, d, J=4.5Hz), 2.67 (1H, m), 3.07 (1H, dd, J=14, 12Hz), 3.23 (1H, dd, J=14, 5Hz), 4.71 (1H, ddd, J=12, 8, 5Hz), 4.80 (1H, dd, J=8, 6Hz), 7.82 (1H, dd, J=6, 6Hz), 7.88-7.98 (3H, m), 8.43 (1H, d, J=8Hz), 8.75 (2x1H, d, J=6Hz), 10.43 (1H, s)

HPLC : 4.7 min. (Nucleosil 5C18, 4 mmφ x 15 cm, MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=492

Example 17-49)

N-[(2R,3R)-3-Ethoxycarbonylaminoethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-3-pyridylalanine methylamide  
methanesulfonate

5  $[\alpha]_D^{24} = -23.2^\circ$  (c 0.31, 1N-HCl aq.)

mp : 189-191°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.87 (1H, m), 1.14 (3H, t, J=7Hz), 1.25 (1H, m), 1.37 (1H, m), 2.10 (1H, ddd, J=9, 9, 3Hz),  
10 2.22 (1H, ddd, J=12, 5, 4Hz), 2.32 (3H, s), 2.38 (1H, m), 2.59 (3H, d, J=5Hz), 2.69 (1H, m), 3.00 (1H, dd, J=14, 12Hz), 3.15 (1H, dd, J=14, 5Hz),  
15 3.93 (2H, q, J=7Hz), 4.61 (1H, m), 6.50 (1H, dd, J=5, 5Hz), 7.81-7.92 (2H, m), 8.29-8.43 (2H, m), 8.70 (1H, d, J=5Hz), 8.78 (1H, s), 10.35 (1H, s)

HPLC : 6.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=452

Example 17-50)

N-[(2R,3R)-3-(N-tert-Butoxycarbonylglycyl)aminoethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine  
methylamide

25  $[\alpha]_D^{24} = -22.2^\circ$  (c 0.20, 1N-HCl aq.)

mp : 217-219°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.72 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.87 (1H, m), 1.13-1.48 (2H, m), 1.38 (3x3H, s), 2.20 (1H, m), 2.45 (1H, m), 2.55 (3H, d, J=4.5Hz),  
30 2.74-2.91 (3H, m), 2.96 (1H, dd, J=14, 6Hz), 3.45 (1H, dd, J=16, 5Hz), 3.50 (1H, dd, J=16, 7Hz), 4.56 (1H, m), 6.82 (1H, dd, J=5, 5Hz), 7.24 (2x1H, d, J=6Hz), 7.87 (1H, q, J=4.5Hz), 8.28 (1H, d, J=8Hz), 8.41 (2x1H, d, J=6Hz), 8.78 (1H, s),  
35 10.35 (1H, s)

HPLC : 8.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 15:85, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=537

5

Example 17-51)

N-[(2R,3R)-4-Hydroxyamino-2-isobutyl-3-(oxamoylamino-  
methyl)succinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{24} = -14.8^\circ$  (c 0.38, 1N-HCl aq.)

10 mp : 221-224°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.80 (3H, d,  
J=7Hz), 0.89 (1H, m), 1.28 (1H, m), 1.38 (1H, m),  
2.22 (1H, ddd, J=10, 9, 4Hz), 2.32-2.52 (2H, m),  
2.60 (3H, d, J=4Hz), 2.97 (1H, m), 3.05 (1H, dd,  
15 J=14, 12Hz), 3.19 (1H, dd, J=14, 5Hz), 4.67 (1H,  
ddd, J=12, 8, 5Hz), 7.79-8.00 (6H, m), 8.48 (1H, d,  
J=8Hz), 8.71 (2x1H, br d, J=6Hz), 10.46 (1H, s)

HPLC : 4.5 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
20 ml/min., at R.T.)

MASS : M+H=451

Example 17-52)

25 N-[(2R,3R)-3-D-Gluconylaminomethyl-4-hydroxyamino-2-  
isobutylsuccinyl]-L-4-pyridylalanine methylamide  
methanesulfonate

$[\alpha]_D^{24} = -3.9^\circ$  (c 0.21, 1N-HCl aq.)

mp : 180-185°C (dec.)

30 NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d,  
J=7Hz), 0.88 (1H, m), 1.29 (1H, m), 1.37 (1H, m),  
2.14 (1H, ddd, J=9, 9, 3Hz), 2.29-2.54 (2H, m),  
2.32 (3H, s), 2.60 (3H, d, J=4.5Hz), 2.88 (1H, m),  
3.07 (1H, dd, J=14, 12Hz), 3.22 (1H, dd, J=14,  
4Hz), 3.41-3.64 (4H, m), 3.88-3.99 (2H, m), 4.70  
35 (1H, ddd, J=12, 8, 4Hz), 7.12 (1H, dd, J=5, 5Hz),

7.90 (2x1H, d, J=6Hz), 7.93 (1H, q, J=4.5Hz), 8.42 (1H, d, J=8Hz), 8.75 (2x1H, br d, J=6Hz), 10.46 (1H, s)

HPLC : 3.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:H<sub>2</sub>O:TFA = 10:90:0.05, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=558

#### Example 18

To a stirred suspension of N-[(2R,3R)-4-benzyloxyamino-3-ethoxycarbonylaminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide (243 mg) in methanol (5 ml) was added 1N aqueous sodium hydroxide solution (1.2 ml) at ambient temperature. The mixture was stirred at the same temperature for 4 hours. The solution was neutralized by dropwise addition of 1N-hydrochloric acid (1.2 ml). The precipitate was collected and washed with water to give N-[(2R,3R)-4-benzyloxyamino-3-carboxyacetylaminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide (216 mg).

$[\alpha]_D^{23} = -38.3^\circ$  (c 0.21, 1N-HCl aq.)

mp : 246-250°C (dec.)

NMR (DMSO-d<sub>6</sub>,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.77 (3H, d, J=7Hz), 0.80 (1H, m), 1.23 (1H, m), 1.37 (1H, m), 2.20 (1H, ddd, J=11, 9, 3Hz), 2.44 (1H, m), 2.55 (3H, d, J=5Hz), 2.62-2.91 (3H, m), 2.95 (1H, dd, J=14, 5Hz), 3.03 (1H, d, J=15Hz), 3.10 (1H, d, J=15Hz), 4.57 (1H, ddd, J=10, 8, 5Hz), 4.72 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 7.24 (2x1H, d, J=7Hz), 7.29-7.42 (5H, m), 7.77-7.93 (2H, m), 8.33 (1H, d, J=8Hz), 8.40 (2x1H, d, J=7Hz), 11.05 (1H, s)

HPLC : 5.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=556

Example 19-1)

N-[(2R,3R)-3-(N-tert-Butoxycarbonylglycyl)aminomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine  
5 methylamide (130 mg) was dissolved in 10% hydrogen chloride in methanol (5 ml). After the solution was stirred at ambient temperature for 40 minutes, the solvent was evaporated in vacuo. The obtained solid was triturated with ethyl acetate, collected and washed with ethyl acetate to  
10 give N-[(2R,3R)-3-glycylaminomethyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide dihydrochloride (86 mg) as a powder.

$[\alpha]_D^{24} = -23.5^\circ$  (c 0.28, 1N-HCl aq.)

mp : 250-255°C (dec.)

15 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.85 (1H, m), 1.26 (1H, m), 1.38 (1H, m), 1.95-2.15 (2H, m), 2.33 (1H, m), 2.62 (3H, d, J=5Hz), 2.68 (1H, m), 3.06 (1H, dd, J=13, 12Hz), 3.28 (1H, dd, J=13, 4Hz), 3.35-3.60 (2H, m), 4.77  
20 (1H, ddd, J=12, 8, 4Hz), 7.98 (2x1H, d, J=7Hz), 8.02-8.20 (4H, m), 8.49 (1H, d, J=8Hz), 8.75 (2x1H, d, J=7Hz), 10.45 (1H, s)

HPLC : 3.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:H<sub>2</sub>O:TFA = 10:90:0.05, 260 nm, flow rate 1.0  
25 ml/min., at R.T.)

MASS : M+H=437

Example 19-2)

N-[(2R,3R)-3-[(2S)-2-Amino-3-hydroxypropionyl]amino-methyl-4-hydroxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine  
30 methylamide dihydrochloride was obtained in substantially the same manner as that of Example 19-1).

$[\alpha]_D^{24} = -17.8^\circ$  (c 0.28, 1N-HCl aq.)

mp : 236-243°C (dec.)

35 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d,

J=7Hz), 0.84 (1H, m), 1.27 (1H, m), 1.36 (1H, m),  
2.01 (1H, m), 2.20-2.48 (2H, m), 2.63 (3H, d,  
J=4.5Hz), 3.06 (1H, dd, J=13, 12Hz), 3.28 (1H, dd,  
J=13, 4Hz), 3.60 (1H, dd, J=11, 7Hz), 3.67 (1H, dd,  
J=11, 3Hz), 3.77 (1H, m), 4.79 (1H, ddd, J=12, 8,  
4Hz), 7.97 (2x1H, d, J=6Hz), 8.07 (1H, q, J=4.5Hz),  
8.15-8.28 (3H, m), 8.50 (1H, d, J=8Hz), 8.73 (2x1H,  
d, J=6Hz), 10.45 (1H, s)

HPLC : 3.1 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 10:90:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=467

#### Example 20-1)

N-[(2R,3R)-4-Benzyloxyamino-3-(2-hydroxyethoxy)carbonyl-aminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide was obtained from N-[(2R,3R)-3-(2-acetoxyethoxy)-carbonylaminomethyl-4-benzyloxyamino-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide in substantially the same manner as that of Example 18.

$[\alpha]_D^{23} = -16.2^\circ$  (c 0.21, 1N-HCl aq.)

mp : 237-240°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.65-0.88 (1H, m), 0.70 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 1.17-1.40 (2H, m),  
2.14 (1H, m), 2.31-2.61 (2H, m), 2.55 (3H, d, J=4.5Hz), 2.70 (1H, m), 2.81 (1H, dd, J=14, 12Hz),  
2.95 (1H, dd, J=14, 5Hz), 3.45-3.58 (2H, m), 3.81-3.98 (2H, m), 4.56 (1H, ddd, J=12, 8, 5Hz), 4.70 (1H, d, J=11Hz), 4.76 (1H, d, J=11Hz), 6.71 (1H, dd, J=6, 6Hz), 7.25 (2x1H, d, J=6Hz), 7.28-7.42 (5H, m), 7.86 (1H, q, J=4.5Hz), 8.36 (1H, d, J=8Hz), 8.39 (2x1H, d, J=6Hz), 10.95 (1H, s)

HPLC : 4.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0  
ml/min., at R.T.)



MASS : M+H=558

The following compounds were obtained in substantially the same manner as that of Example 20-1).

5

Example 20-2)

N-[(2R,3R)-4-Benzyloxyamino-3-hydroxyacetylaminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine methylamide

$[\alpha]_D^{23} = -33.8^\circ$  (c 0.22, 1N-HCl aq.)

10

mp : 239-244°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.78 (3H, d, J=7Hz), 0.82 (1H, m), 1.26 (1H, m), 1.34 (1H, m), 2.23 (1H, ddd, J=9, 9, 4Hz), 2.41-2.53 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.73 (1H, m), 2.38 (1H, dd, J=14, 11Hz), 2.90-3.03 (2H, m), 3.75 (2H, d, J=6Hz), 4.54 (1H, m), 4.71 (1H, d, J=11Hz), 4.78 (1H, d, J=11Hz), 5.45 (1H, t, J=6Hz), 7.21 (1H, m), 7.24 (2x1H, d, J=6Hz), 7.85 (1H, q, J=4.5Hz), 8.35-8.44 (3H, m), 11.09 (1H, s)

15

20

HPLC : 4.8 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=528

25

Example 20-3)

N-[(2R,3R)-4-Benzyloxyamino-3-hydroxyacetamidomethyl-2-isobutylsuccinyl]-L-3-pyridylalanine methylamide

$[\alpha]_D^{24} = -38.8^\circ$  (c 0.24, 1N-HCl aq.)

mp : 253-256°C (dec.)

30

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.71 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.82 (1H, m), 1.25 (1H, m), 1.33 (1H, m), 2.22 (1H, ddd, J=9, 9, 4Hz), 2.47 (1H, m), 2.54 (3H, d, J=4.5Hz), 2.65 (1H, ddd, J=13, 5, 4Hz), 2.82 (1H, dd, J=14, 11Hz), 2.94 (1H, dd, J=14, 6Hz), 3.75 (2H, d, J=6Hz), 4.50 (1H, m), 4.71 (1H,

35

d, J=11Hz), 4.77 (1H, d, J=11Hz), 5.43 (1H, t, J=6Hz), 7.19 (1H, dd, J=5, 5Hz), 7.23 (1H, dd, J=7.5, 5Hz), 7.30-7.42 (5H, m), 7.64 (1H, br d, J=7.5Hz), 7.84 (1H, q, J=4.5Hz), 8.30-8.40 (2H, m),  
5 8.44 (1H, br s), 11.09 (1H, s)

HPLC : 4.9 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 25:75:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=528

10

#### Example 21-1)

N-[(2R,3R)-4-Benzyloxyamino-2-isobutyl-3-(methyl-  
carbamoylacetylaminomethyl)succinyl]-L-4-pyridylalanine  
methanamide was obtained in substantially the same manner as  
15 that of Example 2-1).

$[\alpha]_D^{23} = -46.2^\circ$  (c 0.21, 1N-HCl aq.)

mp : 257-260°C (dec.)

NMR (DMSO-d<sub>6</sub>, δ) : 0.70 (3H, d, J=7Hz), 0.73-0.87 (1H,  
m), 0.77 (3H, d, J=7Hz), 1.23 (1H, m), 1.36 (1H,  
20 m), 2.18 (1H, ddd, J=10, 9, 4Hz), 2.44 (1H, m),  
2.55 (3H, d, J=5Hz), 2.58 (3H, d, J=5Hz), 2.63-2.89  
(2H, m), 2.83 (1H, dd, J=14, 10Hz), 2.90-3.03 (1H,  
m), 2.97 (2H, s), 4.58 (1H, m), 4.70 (1H, d,  
J=11Hz), 4.80 (1H, d, J=11Hz), 7.25 (2x1H, d,  
25 J=7Hz), 7.28-7.42 (5H, m), 7.77-7.93 (3H, m), 8.33  
(1H, d, J=8Hz), 8.40 (2x1H, d, J=6Hz), 11.02 (1H,  
br)

HPLC : 5.0 min. (Nucleosil 5C18, 4 mmφ x 15 cm,  
MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0  
30 ml/min., at R.T.)

MASS : M+H=569

#### Example 21-2)

N-[(2R,3R)-4-Benzyloxyamino-2-isobutyl-3-[(3-methyl-  
35 carbamoylmethyl)ureidomethyl)succinyl]-L-4-pyridylalanine

methylamide was obtained in substantially the same manner as that of Example 2-1).

$[\alpha]_D^{23} = -28.2^\circ$  (c 0.23, 1N-HCl aq.)

mp : 244-249°C (dec.)

5 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.69 (3H, d, J=6.5Hz), 0.75 (3H, d, J=6.5Hz), 0.80 (1H, m), 1.20 (1H, m), 1.34 (1H, m), 2.19 (1H, m), 2.40 (1H, m), 2.56 (3H, d, J=4.5Hz), 2.60 (3H, d, J=4.5Hz), 2.71 (2H, dd, J=6, 6Hz), 2.84 (1H, dd, J=14, 11Hz), 3.00 (1H, dd, J=14, 5Hz), 3.53 (1H, dd, J=17, 6Hz), 3.63 (1H, dd, J=17, 6Hz), 3.75 (2H, d, J=6Hz), 4.56 (1H, ddd, J=11, 8.5, 5Hz), 4.74 (1H, d, J=11Hz), 4.80 (1H, d, J=11Hz), 5.90 (1H, t, J=6Hz), 6.14 (1H, dd, J=6, 6Hz), 7.24 (2x1H, d, J=6Hz), 7.31-7.44 (5H, m), 7.72 (1H, q, J=4.5Hz), 7.84 (1H, q, J=4.5Hz), 8.25 (1H, d, J=8.5Hz), 8.40 (2x1H, d, J=6Hz), 11.05 (1H, s)

HPLC : 4.6 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm, MeCN:0.05% TFA aq. = 25:75, 260 nm, flow rate 1.0 ml/min., at R.T.)

MASS : M+H=584

The following compounds were obtained in substantially the same manner as those of Examples 12-1) and 19-1).

25

Example 22-1)

N-((2R,3R)-3-(2-Aminoethoxy)carbonylaminomethyl-4-hydroxyamino-2-isobutylsuccinyl)-L-4-pyridylalanine methylamide from N-((2R,3R)-4-benzyloxyamino-3-(2-benzyloxy-carbonylamino)ethoxycarbonylaminomethyl-2-isobutylsuccinyl)-L-4-pyridylalanine methylamide

30  $[\alpha]_D^{23} = -19.5^\circ$  (c 0.25, 1N-HCl aq.)

mp : 201-206°C (dec.)

35 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d, J=7Hz), 0.79 (3H, d, J=7Hz), 0.86 (1H, m), 1.28 (1H, m), 1.38 (1H, m),

2.17 (1H, m), 2.43 (1H, m), 2.58 (3H, d,  $J=4.5\text{Hz}$ ),  
2.68-2.89 (3H, m), 2.95 (1H, dd,  $J=14, 4\text{Hz}$ ), 3.20-  
3.70 (2H, m), 3.88 (2H, t,  $J=6\text{Hz}$ ), 4.57 (1H, m),  
6.52 (1H, m), 7.26 (2x1H, d,  $J=6\text{Hz}$ ), 7.87 (1H, q,  
5  $J=4.5\text{Hz}$ ), 8.35 (1H, d,  $J=8\text{Hz}$ ), 8.50 (2x1H, d,  
 $J=6\text{Hz}$ )

HPLC : 3.3 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:0.05% TFAaq. = 10:90, 260 nm, flow rate 1.0  
ml/min., at R.T.)

10 MASS : M+H=467

Example 22-2)

N-((2R,3R)-4-Hydroxyamino-3-[(4S)-2-oxoimidazolidin-4-  
yl)carbonylaminomethyl-2-isobutylsuccinyl]-L-4-pyridylalanine  
15 methylamide methanesulfonate from N-((2R,3R)-4-  
benzyloxyamino-3-[(4S)-3-benzyloxycarbonyl-2-oxoimidazolidin-  
4-yl]carbonylaminomethyl-2-isobutylsuccinyl)-L-4-  
pyridylalanine methylamide

$[\alpha]_D^{24} = -25.4^\circ$  (c 0.33, 1N-HCl aq.)

20 mp : 201-204°C (dec.)

NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.73 (3H, d,  $J=7\text{Hz}$ ), 0.78 (3H, d,  
 $J=7\text{Hz}$ ), 0.85 (1H, m), 1.25 (1H, m), 1.37 (1H, m),  
2.10 (1H, ddd,  $J=9, 9, 3\text{Hz}$ ), 2.30 (3H, s), 2.32-  
2.52 (2H, m), 2.55-2.70 (1H, m), 2.60 (3H, d,  
25  $J=5\text{Hz}$ ), 3.05 (1H, dd,  $J=14, 12\text{Hz}$ ), 3.13-3.28 (2H,  
m), 3.46 (1H, dd,  $J=10, 9\text{Hz}$ ), 4.00 (1H, m), 4.73  
(1H, m), 6.28 (1H, br), 7.48 (1H, dd,  $J=6, 6\text{Hz}$ ),  
7.88 (2x1H, d,  $J=6\text{Hz}$ ), 7.93 (1H, q,  $J=5\text{Hz}$ ), 8.41  
(1H, d,  $J=8\text{Hz}$ ), 8.72 (2x1H, d,  $J=6\text{Hz}$ ), 10.43 (1H,  
30 s)

HPLC : 3.7 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
MeCN:H<sub>2</sub>O:TFA = 10:90:0.05, 260 nm, flow rate 1.0  
ml/min., at R.T.)

MASS : M+H=492

Example 23

To a stirred suspension of N-[(2R,3R)-4-hydroxyamino-2-isobutyl-3-(methanesulfonylaminomethyl)succinyl]-L-3-pyridylalanine methylamide (124 mg) in ethanol (1 ml) was  
5 added methanesulfonic acid (28 mg). The mixture was heated until a clear solution was obtained. The solution was allowed to cool to ambient temperature and diluted with ethyl acetate with stirring. The precipitate was collected and washed with ethyl acetate to give N-[(2R,3R)-4-hydroxyamino-  
10 2-isobutyl-3-(methanesulfonylaminomethyl)succinyl]-L-3-pyridylalanine methylamide methanesulfonate (142 mg) as a powder.

$[\alpha]_D^{23} = -12.4^\circ$  (c 0.32, 1N-HCl aq.)

mp : 140-146°C (dec.)

15 NMR (DMSO- $d_6$ ,  $\delta$ ) : 0.74 (3H, d, J=7Hz), 0.80 (3H, d, J=7Hz), 0.90 (1H, m), 1.29 (1H, m), 1.39 (1H, m), 2.13 (1H, ddd, J=9, 9, 3Hz), 2.23 (1H, ddd, J=13, 5, 4Hz), 2.32 (3H, s), 2.37 (1H, m), 2.58 (3H, d, J=5Hz), 2.80 (1H, m), 3.01 (1H, dd, J=14, 11Hz),  
20 3.13 (1H, dd, J=14, 5Hz), 4.56 (1H, ddd, J=11, 8, 5Hz), 6.72 (1H, dd, J=6, 5Hz), 7.85-7.97 (2H, m), 8.35 (1H, d, J=8Hz), 8.40 (1H, d, J=7.5Hz), 8.75 (1H, d, J=5Hz), 8.80 (1H, s), 10.49 (1H, s)

HPLC : 4.1 min. (Nucleosil 5C18, 4 mm $\phi$  x 15 cm,  
25 MeCN:0.05% TFA aq. = 10:90, 260 nm, flow rate 1.0 ml/min., at R.T.)

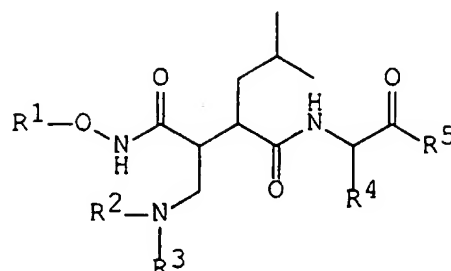
MASS : M+H=458

30

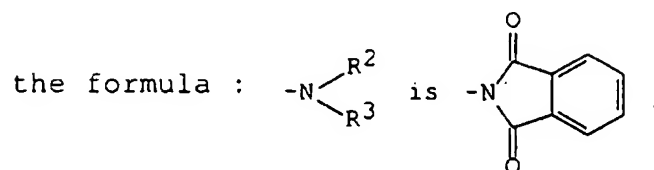
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## CLAIMS

1. A compound of the following formula :



in which R<sup>1</sup> is hydrogen or hydroxy-protective group,  
 R<sup>2</sup> is hydrogen or acyl,  
 R<sup>3</sup> is hydrogen or lower alkyl, or



R<sup>4</sup> is heterocyclic(lower)alkyl, and  
 R<sup>5</sup> is lower alkoxy or lower alkylamino,  
 or a pharmaceutically acceptable salt thereof.

2. The compound of Claim 1, wherein

R<sup>1</sup> is hydrogen,

R<sup>2</sup> is hydrogen; oxamoyl; lower alkanoyl;

lower alkanesulfonyl; lower alkoxycarbonyl;

(C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl;

di(lower)alkylamino(lower)alkanoyl;

lower alkylcarbamoyl; di(lower)alkylcarbamoyl;

N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl;

C<sub>6</sub>-C<sub>10</sub> aroyl; C<sub>6</sub>-C<sub>10</sub> arenesulfonyl;

C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl; heterocyclic-carbonyl

optionally substituted by the group consisting of  
acyl, lower alkyl, hydroxy and oxo;  
heterocyclic-carbamoyl;  
(C<sub>6</sub>-C<sub>10</sub>) aryloxy(lower)alkanoyl;  
5 heterocyclic(lower)alkanoyl;  
lower alkylcarbamoyl(lower)alkanoyl;  
carboxy(lower)alkanoyl; protected  
carboxy(lower)alkanoyl; hydroxy(lower)alkanoyl;  
protected hydroxy(lower)alkanoyl;  
10 lower alkoxy(lower)alkanoyl;  
lower alkoxy(lower)alkoxycarbonyl;  
amino(lower)alkoxycarbonyl;  
protected amino(lower)alkoxycarbonyl;  
lower alkoxycarbonyl(lower)alkylcarbamoyl;  
15 lower alkylsulfonyl(lower)alkanoyl;  
hydroxy(lower)alkoxycarbonyl;  
protected hydroxy(lower)alkoxycarbonyl;  
lower alkanoyl substituted by the group consisting  
of amino and hydroxy; lower alkanoyl substituted by  
20 the group consisting of protected amino and  
hydroxy; amino(lower)alkanoyl; or protected  
amino(lower)alkanoyl;  
said heterocyclic groups being  
unsaturated 3- to 8-membered heteromonocyclic  
25 group containing 1 to 4 nitrogen atom(s),  
saturated 3- to 8-membered heteromonocyclic  
group containing 1 to 4 nitrogen atom(s),  
unsaturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 4 nitrogen  
30 atom(s),  
saturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 4 nitrogen  
atom(s),  
unsaturated 3- to 8-membered heteromonocyclic  
35 group containing 1 to 2 oxygen atom(s) and 1 to 3

nitrogen atom(s),

saturated 3- to 8-membered heteromonocyclic group containing 1 to 2 oxygen atom(s) and 1 to 3 nitrogen atom(s),

5           unsaturated 7- to 12-membered condensed heterocyclic group containing 1 to 2 oxygen atom(s) and 1 to 3 nitrogen atom(s),

          unsaturated 3- to 8-membered heteromonocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3  
10           nitrogen atom(s),

saturated 3- to 8-membered heteromonocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3 nitrogen atom(s),

          unsaturated 7- to 12-membered condensed  
15           heterocyclic group containing 1 to 2 sulfur atom(s) and 1 to 3 nitrogen atom(s),

          unsaturated 3- to 8-membered heteromonocyclic group containing an oxygen atom,

          unsaturated 3- to 8-membered heteromonocyclic  
20           group containing an oxygen atom and 1 to 2 sulfur atom(s),

          unsaturated 7- to 12-membered condensed heterocyclic group containing 1 to 2 sulfur atom(s), or

25           unsaturated 7- to 12-membered condensed heterocyclic group containing an oxygen atom and 1 to 2 sulfur atom(s), and

$R^4$  is heterocyclic(lower)alkyl,

said heterocyclic groups being

30           unsaturated 3- to 8-membered heteromonocyclic group containing 1 to 4 nitrogen atom(s),

saturated 3- to 8-membered heteromonocyclic group containing 1 to 4 nitrogen atom(s),

          unsaturated 7- to 12-membered condensed  
35           heterocyclic group containing 1 to 4 nitrogen



atom(s),

saturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 4 nitrogen  
atom(s),

5           unsaturated 3- to 8-membered heteromonocyclic  
group containing 1 to 2 oxygen atom(s) and 1 to 3  
nitrogen atom(s),

          saturated 3- to 8-membered heteromonocyclic  
group containing 1 to 2 oxygen atom(s) and 1 to 3  
10       nitrogen atom(s),

          unsaturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 2 oxygen atom(s)  
and 1 to 3 nitrogen atom(s),

          unsaturated 3- to 8-membered heteromonocyclic  
15       group containing 1 to 2 sulfur atom(s) and 1 to 3  
nitrogen atom(s),

          saturated 3- to 8-membered heteromonocyclic  
group containing 1 to 2 sulfur atom(s) and 1 to 3  
nitrogen atom(s),

20       unsaturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 2 sulfur atom(s)  
and 1 to 3 nitrogen atom(s),

          unsaturated 3- to 8-membered heteromonocyclic  
group containing an oxygen atom,

25       unsaturated 3- to 8-membered heteromonocyclic  
group containing an oxygen atom and 1 to 2 sulfur  
atom(s),

          unsaturated 7- to 12-membered condensed  
heterocyclic group containing 1 to 2 sulfur  
30       atom(s), or

          unsaturated 7- to 12-membered condensed  
heterocyclic group containing an oxygen atom and 1  
to 2 sulfur atom(s).

35       3.   The compound of Claim 2, wherein

R<sup>2</sup> is hydrogen; oxamoyl; lower alkanoyl;  
lower alkanesulfonyl; lower alkoxycarbonyl;  
(C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl;  
di(lower)alkylamino(lower)alkanoyl;  
5 lower alkylcarbamoyl; di(lower)alkylcarbamoyl;  
N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl;  
C<sub>6</sub>-C<sub>10</sub> aroyl; C<sub>6</sub>-C<sub>10</sub> arenesulfonyl;  
C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl; heterocyclic-carbonyl  
optionally substituted by the group consisting of  
10 C<sub>6</sub>-C<sub>10</sub> ar(lower)alkoxycarbonyl, lower alkyl,  
hydroxy and oxo, said heterocyclic group being  
unsaturated 5- or 6-membered  
heteromonocyclic group containing 1 to 4  
nitrogen atom(s),  
15 saturated 5- or 6-membered  
heteromonocyclic group containing 1 to 4  
nitrogen atom(s),  
unsaturated 9- or 10-membered bicyclic  
heterocyclic group containing 1 to 4 nitrogen  
20 atom(s),  
unsaturated 5- or 6-membered  
heteromonocyclic group containing 1 to 2  
oxygen atom, or  
saturated 5- or 6-membered  
25 heteromonocyclic group containing 1 to 2  
oxygen atom;  
heterocyclic-carbamoyl, said heterocyclic group  
being  
unsaturated 5- or 6-membered  
30 heteromonocyclic group containing 1 to 4  
nitrogen atom(s),  
saturated 5- or 6-membered  
heteromonocyclic group containing 1 to 4  
nitrogen atom(s),  
35 unsaturated 9- or 10-membered bicyclic

heterocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 5- or 6-membered heteromonocyclic group containing 1 to 2 oxygen atom, or

saturated 5- or 6-membered heteromonocyclic group containing 1 to 2 oxygen atom;

(C<sub>6</sub>-C<sub>10</sub>)aryloxy(lower)alkanoyl; heterocyclic(lower)alkanoyl, said heterocyclic group being

unsaturated 5- or 6-membered heteromonocyclic group containing 1 to 4 nitrogen atom(s)

saturated 5- or 6-membered heteromonocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 9- or 10-membered bicyclic heterocyclic group containing 1 to 4 nitrogen atom(s),

unsaturated 5- or 6-membered heteromonocyclic group containing 1 to 2 oxygen atom(s), or

saturated 5- or 6-membered heteromonocyclic group containing 1 to 2 oxygen atom(s);

lower alkylcarbamoyl(lower)alkanoyl; carboxy(lower)alkanoyl; protected carboxy(lower)alkanoyl; hydroxy(lower)alkanoyl; protected hydroxy(lower)alkanoyl; lower alkoxy(lower)alkanoyl; lower alkoxy(lower)alkoxycarbonyl; amino(lower)alkoxycarbonyl; C<sub>6</sub>-C<sub>10</sub> ar(lower)alkoxycarbonylamino(lower)alkoxycarbonyl; lower alkoxycarbonyl(lower)alkylcarbamoyl;

lower alkylsulfonyl(lower)alkanoyl;  
hydroxy(lower)alkoxycarbonyl; protected  
hydroxy(lower)alkoxycarbonyl; lower alkanoyl  
substituted by the group consisting of amino and  
hydroxy; lower alkanoyl substituted by the group  
consisting of protected amino and hydroxy;  
amino(lower)alkanoyl; or protected  
amino(lower)alkanoyl; and

R<sup>4</sup> is heterocyclic(lower)alkyl, said heterocyclic group  
being

unsaturated 5- or 6-membered heteromonocyclic  
group containing 1 to 4 nitrogen atom(s),

saturated 5- or 6-membered heteromonocyclic  
group containing 1 to 4 nitrogen atom(s),

unsaturated 9- or 10-membered bicyclic  
heterocyclic group containing 1 to 4 nitrogen  
atom(s),

unsaturated 5- or 6-membered heteromonocyclic  
group containing 1 to 2 oxygen atom(s), or

saturated 5- or 6-membered heteromonocyclic  
group containing 1 to 2 oxygen atom(s).

4. The compound of Claim 3, wherein

R<sup>2</sup> is hydrogen; oxamoyl; lower alkanoyl;

lower alkanesulfonyl; lower alkoxycarbonyl;

(C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl;

di(lower)alkylamino(lower)alkanoyl;

lower alkylcarbamoyl; di(lower)alkylcarbamoyl;

N-[(lower)alkylcarbamoyl(lower)alkyl]carbamoyl;

C<sub>6</sub>-C<sub>10</sub> aroyl; C<sub>6</sub>-C<sub>10</sub> arenesulfonyl;

C<sub>6</sub>-C<sub>10</sub> arylcarbamoyl; heterocyclic-carbonyl

optionally substituted by the group consisting of

C<sub>6</sub>-C<sub>10</sub> ar(lower)alkoxycarbonyl, lower alkyl,

hydroxy and oxo, said heterocyclic group being

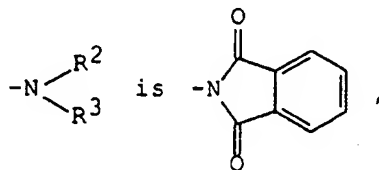
pyrrolyl, pyridyl, pyrazinyl, pyrrolidinyl,

imidazolidinyl, indolyl, isoindolyl, quinolyl,  
isoquinolyl, furyl, or oxolanyl;  
pyridylcarbamoyl;  
(C<sub>6</sub>-C<sub>10</sub>)aryloxy(lower)alkanoyl;  
5 heterocyclic(lower)alkanoyl, said heterocyclic  
group being  
imidazolyl or pyridyl;  
lower alkylcarbamoyl(lower)alkanoyl;  
carboxy(lower)alkanoyl;  
10 lower alkoxycarbonyl(lower)alkanoyl;  
hydroxy(lower)alkanoyl;  
lower alkanoyloxy(lower)alkanoyl;  
lower alkoxy(lower)alkanoyl;  
lower alkoxy(lower)alkoxycarbonyl;  
15 amino(lower)alkoxycarbonyl; C<sub>6</sub>-C<sub>10</sub> ar(lower)-  
alkoxycarbonylamino(lower)alkoxycarbonyl;  
lower alkoxycarbonyl(lower)alkylcarbamoyl;  
lower alkylsulfonyl(lower)alkanoyl;  
hydroxy(lower)alkoxycarbonyl;  
20 lower alkanoyloxy(lower)alkoxycarbonyl;  
lower alkanoyl substituted by the group consisting  
of amino and hydroxy; lower alkanoyl substituted by  
the group consisting of lower alkoxycarbonylamino  
and hydroxy; amino(lower)alkanoyl; lower  
25 alkanoylamino(lower)alkanoyl, or lower  
alkoxycarbonylamino(lower)alkanoyl; and  
R<sup>4</sup> is pyridyl(lower)alkyl.

5. The compound of claim 4, wherein  
30 R<sup>2</sup> is hydrogen;  
oxamoyl;  
C<sub>1</sub>-C<sub>6</sub> alkanoyl optionally substituted by halogen;  
C<sub>1</sub>-C<sub>4</sub> alkanesulfonyl;  
C<sub>1</sub>-C<sub>4</sub> alkoxycarbonyl;  
35 (C<sub>3</sub>-C<sub>7</sub>)cycloalkanecarbonyl;

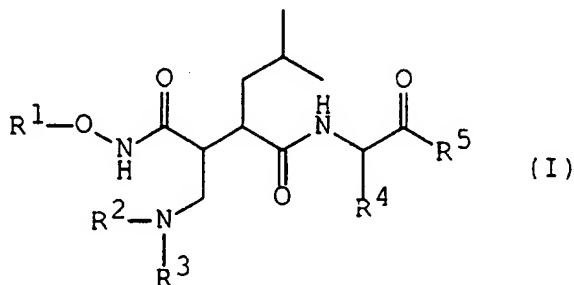
di(C<sub>1</sub>-C<sub>4</sub>)alkylamino(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkylcarbamoyl;  
di(C<sub>1</sub>-C<sub>4</sub>)alkylcarbamoyl;  
N-[(C<sub>1</sub>-C<sub>4</sub>)alkylcarbamoyl(C<sub>1</sub>-C<sub>4</sub>)alkyl]carbamoyl;  
5 benzoyl;  
benzenesulfonyl;  
phenylcarbamoyl;  
pyrrolylcarbonyl;  
pyridinecarbonyl optionally substituted by C<sub>1</sub>-C<sub>4</sub>  
10 alkyl;  
pyrazinylcarbonyl;  
pyrrolidinylcarbonyl optionally substituted by oxo;  
imidazoliziny carbonyl optionally substituted by  
the group consisting of oxo phenyl(C<sub>1</sub>-C<sub>4</sub>)-  
15 alkoxycarbonyl;  
quinolinecarbonyl optionally substituted by  
hydroxy;  
indoylecarbonyl; isoindolylecarbonyl;  
furoyl;  
20 oxolanecarbonyl optionally substituted by oxo;  
pyridylcarbamoyl;  
phenoxy(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
imidazolyl(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
pyridyl(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
25 piperidinyl(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkylcarbamoyl(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
carboxy(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkoxycarbonyl(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
mono- or di- or tri- or tetra- or pentahydroxy-  
30 (C<sub>1</sub>-C<sub>6</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkanoyloxy(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkoxy(C<sub>1</sub>-C<sub>4</sub>)alkanoyl;  
C<sub>1</sub>-C<sub>4</sub> alkoxy(C<sub>1</sub>-C<sub>4</sub>)alkoxycarbonyl;  
amino(C<sub>1</sub>-C<sub>4</sub>)alkoxycarbonyl;  
35 phenyl(C<sub>1</sub>-C<sub>4</sub>)alkoxycarbonylamino(C<sub>1</sub>-C<sub>4</sub>)-

alkoxycarbonyl;  
 $C_1-C_4$  alkoxycarbonyl( $C_1-C_4$ )alkylcarbamoyl;  
 $C_1-C_4$  alkylsulfonyl( $C_1-C_4$ )alkanoyl;  
hydroxy( $C_1-C_4$ )alkoxycarbonyl;  
5  $C_1-C_4$  alkanoyloxy( $C_1-C_4$ )alkoxycarbonyl;  
 $C_1-C_4$  alkanoyl substituted by the group consisting  
of amino and hydroxy;  
 $C_1-C_4$  alkanoyl substituted by the group consisting  
of  $C_1-C_4$  alkoxycarbonylamino and hydroxy;  
10 amino( $C_1-C_4$ )alkanoyl;  
 $C_1-C_4$  alkanoylamino( $C_1-C_4$ )alkanoyl;  
 $C_1-C_4$  alkoxycarbonylamino( $C_1-C_4$ )alkanoyl,  
 $R^3$  is hydrogen or  $C_1-C_4$  alkyl, or the formula :



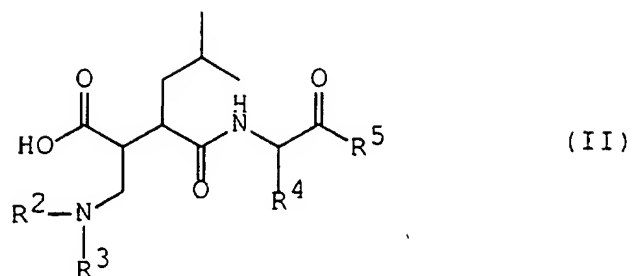
$R^4$  is pyridyl( $C_1-C_4$ )alkyl, and  
 $R^5$  is  $C_1-C_4$  alkoxy or  $C_1-C_4$  alkylamino.

25 6. A process for the preparation of a compound of the  
formula :



35 or a salt thereof, which comprises

(a) reacting a compound of the formula :

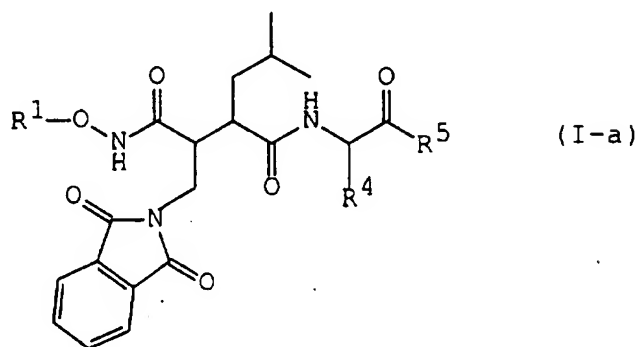


10  
or a reactive derivative at the carboxy group,  
or a salt thereof with a compound of the formula :



or a reactive derivative at the amino group,  
or a salt thereof, to give a compound of the formula (I)  
or a salt thereof; or

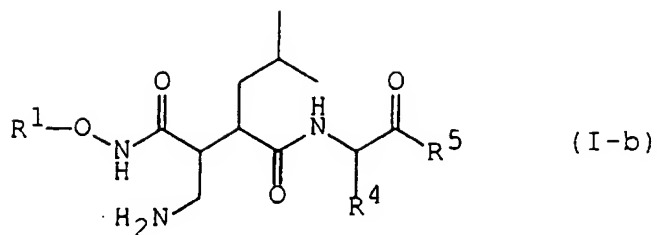
20 (b) subjecting a compound of the formula :



or a salt thereof to a removal reaction of the  
phthalimido moiety to give a compound of the formula :

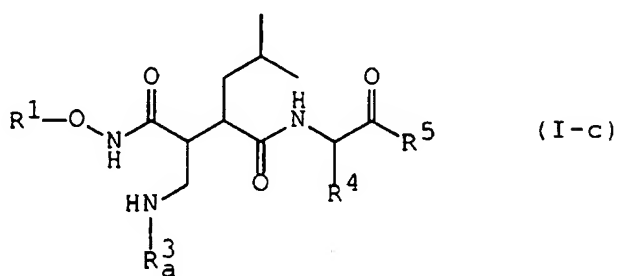
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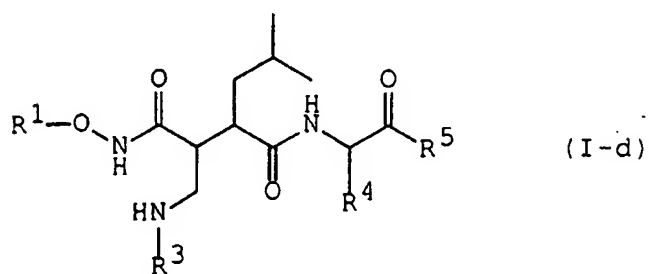
or a salt thereof; or

- 10 (c) alkylating the amino group of a compound of the above formula (I-b) or a salt thereof, to give a compound of the formula :



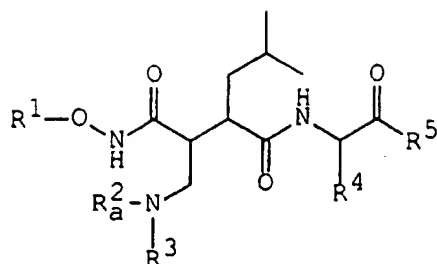
20 or a salt thereof; or

- (d) acylating a compound of the formula :



30 or a salt thereof to give a compound of the formula :

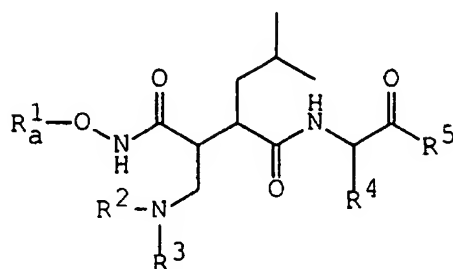
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(I-e)

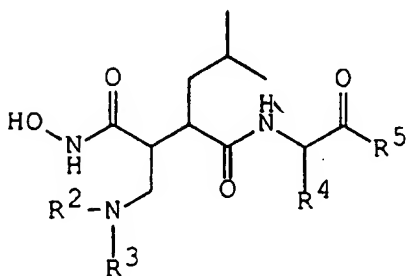
10 or a salt thereof; or

(e) subjecting a compound of the formula :



( I - f )

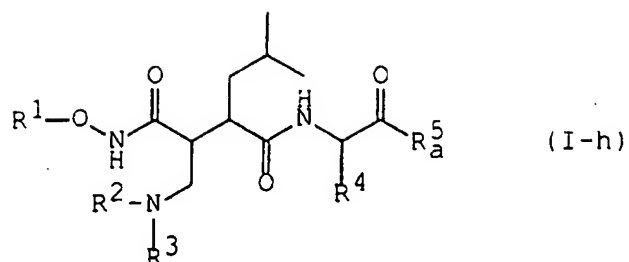
or a salt thereof to a removal reaction of the hydroxy-protective group to give a compound of the formula :



( I - g )

or a salt thereof; or

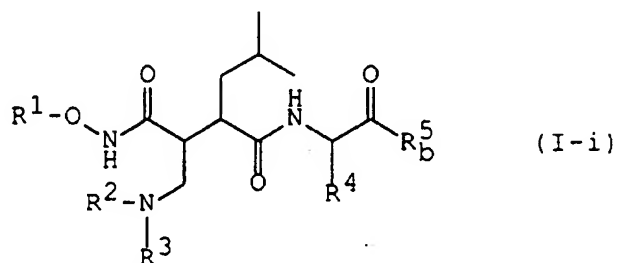
35 (f) reacting a compound of the formula :



10 or a salt thereof, with a compound of the formula :

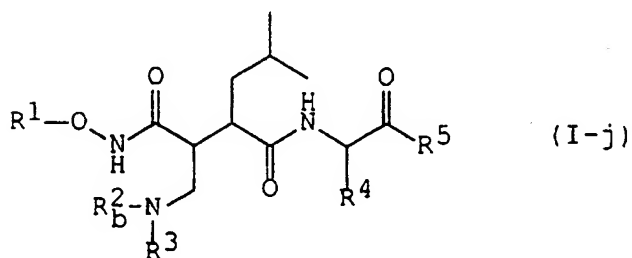


15 or its reactive derivative at the amino group,  
or a salt thereof, to give a compound of the formula :



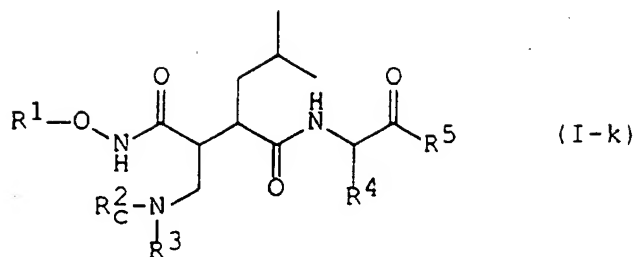
or a salt thereof; or

25 (g) subjecting a compound of the formula :



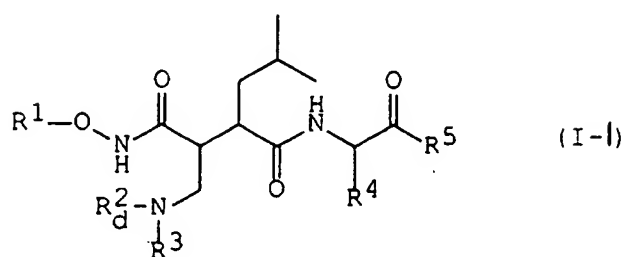
35 or a salt thereof, to a removal reaction of the carboxy-  
protective group on R<sub>b</sub><sup>2</sup>, to give a compound of the

formula :



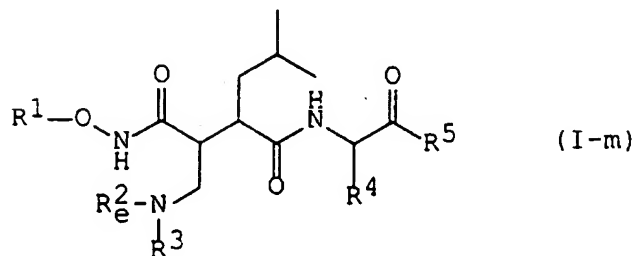
10 or a salt thereof; or

(h) subjecting a compound of the formula :



20

or a salt thereof, to a removal reaction of the amino-protective group on R<sub>Q</sub><sup>2</sup>, to give a compound of the formula :



30

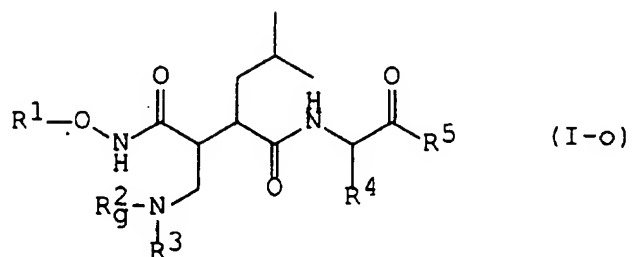
35 or a salt thereof; or

(i) subjecting a compound of the formula :

5

10 or a salt thereof, to a removal reaction of the hydroxy-  
protective group on  $R_f^2$ , to give a compound of the  
formula :

15

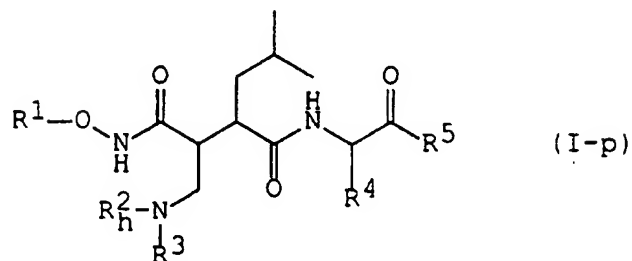


20

or a salt thereof; or

(j) reacting a compound of the formula :

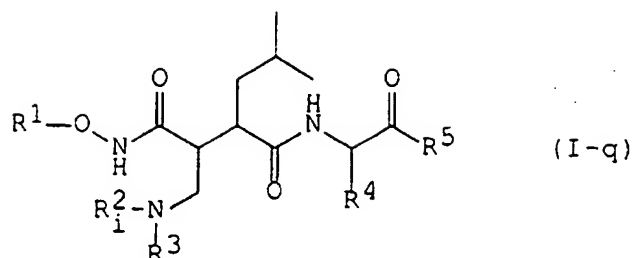
25



30

or a salt thereof, with lower alkylamine, to give a  
35 compound of the formula :

35



or a salt thereof;

10 in which  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  are each as defined in Claim 1,

$R_a^1$  is hydroxy-protective group,

$R_a^2$  is acyl,

$R_b^2$  is protected carboxy(lower)alkanoyl,

15  $R_c^2$  is carboxy(lower)alkanoyl,

$R_d^2$  is protected amino(lower)alkoxycarbonyl,

protected amino(lower)alkanoyl,

lower alkanoyl substituted by protected amino and hydroxy, or N-protected

20 imidazolidinyl optionally substituted by oxo,

$R_e^2$  is amino(lower)alkoxycarbonyl,

amino(lower)alkanoyl,

lower alkanoyl substituted by amino and hydroxy, or imidazolidinyl optionally

25 substituted by oxo,

$R_f^2$  is protected hydroxy(lower)alkoxycarbonyl,

or protected hydroxy(lower)alkanoyl,

$R_g^2$  is hydroxy(lower)alkoxycarbonyl, or

30 hydroxy(lower)alkanoyl,

$R_h^2$  is lower alkoxycarbonyl(lower)-

alkylcarbamoyle or lower alkoxycarbonyl-lower alkanoyl,

$R_i^2$  is lower alkylcarbamoyle(lower)-

35 alkylcarbamoyle or lower alkylcarbamoyle

lower alkanoyl,

$R_a^3$  is lower alkyl,

$R_a^5$  is lower alkoxy, and

$R_b^5$  is lower alkylamino.

5

7. A pharmaceutical composition which comprises a compound of Claim 1 or a pharmaceutically acceptable salt thereof and a pharmaceutically acceptable carrier or excipient.

10

8. A process for preparing a pharmaceutical composition which comprises admixing a compound of Claim 1 or a pharmaceutically acceptable salt thereof with a pharmaceutically acceptable carrier or excipient.

15

9. A compound of Claim 1 or a pharmaceutically acceptable salt thereof for use as a medicament.

10. A compound of Claim 1 or a pharmaceutically acceptable salt thereof for use as an inhibitor of MMP or  $TNF_\alpha$ .

20

11. A use of a compound of Claim 1 or a pharmaceutically acceptable salt thereof for manufacturing a medicament for treating and/or preventing MMP or  $TNF_\alpha$  mediated diseases.

25

12. A method for treating and/or preventing MMP or  $TNF_\alpha$  mediated diseases which comprises administering a compound of claim 1 or a pharmaceutically acceptable salt thereof to a human being or an animal.

30

# INTERNATIONAL SEARCH REPORT

Inter. Appl. No.

PCT/JP 97/02004

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 C07D213/55 C07D213/56 C07D213/81 C07D213/82 C07D401/12  
C07D405/12 A61K31/44

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 096, no. 006, 28 June 1996 & JP 08 053403 A (FUJISAWA PHARMACEUT CO LTD), 27 February 1996, see abstract ---	1-12
Y	WO 95 19965 A (GLYCOMED INC) 27 July 1995 see claims; example 20 ---	1-12
Y	WO 95 19956 A (BRITISH BIOTECH PHARM ;BECKETT RAYMOND PAUL (GB); WHITTAKER MARK ( ) 27 July 1995 see claims; example 37 ---	1-12
A	WO 93 24449 A (CELLTECH LTD ;PORTER JOHN ROBERT (GB); MORPHY JOHN RICHARD (GB); M) 9 December 1993 see the whole document -----	1-12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*&\* document member of the same patent family

Date of the actual completion of the international search

17 September 1997

Date of mailing of the international search report

26.09.97

Name and mailing address of the ISA

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Authorized officer

Bosma, P



# INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP 97/02004

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:  
Remark: Although claim(s) 12  
is(are) directed to a method of treatment of the human/animal  
body, the search has been carried out and based on the alleged  
effects of the compound/composition.
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such  
an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all  
searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment  
of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report  
covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is  
restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/JP 97/02004

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